ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 433

TECHNICAL ARTICLES:

Conveyor Plant at the Coaling Station at New Buffalo, Mich.; Chicago & West Michigan Ry. (*illustrated*) . 434
Traction Engines and Steam Road Rollers... 434
The Sargent Smoke Preventing Apparatus..... 436
The Engineering Schools of the United States, XXXI. 437
Uniform Practice in Pile Driving, III. (*illustrated*).... 438
The Flow of Thick Sheets of Water Over Dams (*illustrated*). 440
Failures in the Necks of Chilled Iron Rolls..... 440
Cantilever Supports for a Swing Bridge (*illustrated*).. 441
Street Cleaning in Philadelphia in 1891..... 441
Portland Cement Packing Rings..... 442
Legal Decisions..... 442
The Type-Writer in Cipher Writing..... 446
Mill Building Construction (*illustrated, with inset*).... 446
Storage Battery Street Cars in Paris..... 451
Transition Curves on Street Railway Lines (*illustrated*)..... 451
Irrigation Canals in India..... 452
Electric Welding in Carriage Manufactories..... 453
Engineering Schools in India..... 454

PERSONALS, NEW PUBLICATIONS, SOCIETY PROCEEDINGS..... 442-443

EDITORIAL NOTES..... 444

The Fallibility of Press Reports of Railway Accidents—The Breaking of Chilled Rolls—The Use of Ball Bearings.

EDITORIALS:

The Ethics of Consulting Practice 444

LETTERS TO THE EDITOR..... 446

To Bridge Engineers—Continuous Rails—Heavy Hauling on Pavements—Mr. Frizell's Formula for Wide-Crested Weirs.

CONSTRUCTION NEWS..... 434-436

Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

The English trial of an American "Harveyized" plate took place on board the Admiralty proving hulk Nov. 2, in Portsmouth Harbor. The plate, which was affixed to the stern of the vessel, was 8 ft. high by 6 ft. wide, and was 10½ ins. thick. It was attacked by a 6 in. breech-loading rifle, firing three howitzer and two Palliser armor-piercing projectiles, weighing 100 lbs. each, with the usual velocity adopted in all the Admiralty tests, namely, 2,020 ft. a second. All the projectiles were completely destroyed, being broken into small fragments, and not a single crack was developed in the plate. The trial, says the London dispatches, is considered by experts to be the most important that has ever taken place in England, and may result in the adoption of the American process for making armor for ironclads. The Russian government will also test the Harveyized plate in competition with Schneider & Co., Brown & Co., and Cammell armor plate. The test will commence on Nov. 15, at Okhta, the Russian proving ground. The Harvey plate will be 6×8 ft., and 10 ins. thick, and is now on its way to St. Petersburg from the works of Vickers & Co., the English armor-plate makers, who represent the Harvey process in England.

A plan for the electric distribution of mail matter between the railway stations, World's Columbian Exposition and the general post office in Chicago, has been submitted to the Post Office Department. The plan proposes cables, high enough to clear all buildings, between the points named, and on these cars would be sent by electric power at high speeds, and so arranged as to dump the mail bags at given points and return with other matter sent up in an elevator. The U. S. Rapid Transit Co., of Chicago, is promoting the scheme.

The average life of a 20-c. p. incandescent lamp at the Massachusetts cotton mills in Lowell is 1,208 hours, according to the statement of Mr. W. S. Southworth, at the recent meeting of the New England Cotton Manufacturers' Association. The plant consists of an Edison dynamo with 600 lamps connected to its circuit. The average number of lamp renewals yearly is 276. Estimating the cost of the power used at $25 per HP. per annum, the total annual cost for lighting, including interest and depreciation on the plant, is $1,160. The cost of gas to furnish the same light at $1.10 per thousand would be $1,600. This makes the electric light cost the same as gas at 85 cts. per thousand.

Armor plate now being made at Bethlehem, Pa., for the battle ship "Indiana," requires an ingot weighing 84 tons, and the plate when rolled will be 17 ins. thick. The first curved Harveyized plate is ready for shipment to Indian Head for testing. It is 9 ft. 6 ins. long, 6 ft. wide and 10½ ins. thick.

The Schuylkill Canal, after being practically abandoned, may be put into condition for navigation next year, says the Philadelphia "Press." The reason given is that the great glut of traffic, particularly in coal, on the main line of the Reading Railroad, makes this relief expedient.

A new air brake, invented by a Mr. Boluss, of Wilkes Barre, Pa., is soon to be tested on a Central Railroad of New Jersey train. Newspaper reports say that the peculiar advantage of the brake is that the surplus air is saved by being "exhausted back into the receiver." While there may be some remote possibilities of improvement in this direction, the scheme seems pretty closely related to the old idea of making a steam engine exhaust into its own boiler. Besides, nobody is borrowing any trouble nowadays about the waste of air in using air brakes.

The most serious railway accident of the week was a head collision Nov. 1 near Galena, Ill., on the Great Western Ry. A construction train entered the Rice tunnel without orders and collided with a freight train in the tunnel. One man was killed, two were fatally injured, and several others injured more or less seriously.

One span of a bridge carrying the Cleveland, Chicago, Cincinnati & St. Louis Ry. over the Wabash R. R. at Terre Haute, Ind., was broken down Oct. 28 by a head collision of freight trains on the structure. Both engines and a number of stock cars went down. One man was killed.

The English railway accident noted last week, by which 10 persons were killed and a large number injured in a rear collision between a southbound express train and a freight train, is said to have been caused by a signalman falling asleep while on duty. According to his statements, as published in the daily press, he had passed the night attending upon his dying child, and after the child's death he asked the station master for leave of absence, but this was refused unless he could find a substitute, which he was unable to do, and thus went on duty tired out mentally and physically. We have already had occasion to refer to the overworking of railway employees in England, as evidenced by the accident reports of the Board of Trade inspectors, and if the signalman's statement is correct it will give special interest to the evidence of the witnesses now testifying as to railway management before the royal labor commission. The men assert that they are overworked, while the railway officials testify that it is impossible to work the traffic of their lines on a fixed basis of ten hours. The English cars are said to have smashed to pieces, while the Pullman car was little damaged and nobody in it was injured. The express was from Edinburgh to London, by the east coast route, and the accident occurred at Thirsk, on the Northeastern Railway.

The promoters of the Panama Canal have asked the Colombian Government to extend their concession one year longer. The old concession lapses in February, 1893. Colombia demands $2,000,000 as one of the considerations under which the work can be resumed. Prospects are evidently not very bright for the Canal or for the treasury of the State of Colombia.

The Congressional Library at Washington, now nearing completion, covers three acres of ground, will cost about $6,000,000 and will hold 5,000,000 books. It is built of granite without, and iron, brick and marble within. The present library contains 650,000 volumes and 250,000 pamphlets. Congress annually appropriates only $11,000 for the purchase of foreign books, and Mr. Spofford hopes that this meager sum will be increased to an amount nearer in proportion to the $60,000 per year at the disposal of the British Museum Library for the same purpose. The plea of economical Congressmen that there is no room for the new books will soon be without foundation in truth.

A report on water-works for the city of Tacoma, Wash., has just been made by Mr. Rudolph Hering, M. Am. Soc. C. E. At present the city is supplied by the Tacoma Light & Water Co., but the city proposes to acquire works by purchase or construction. Mr. Hering describes the present works in detail, and their proposed extensions; he also outlines three other plans for a supply. In conclusion he recommends the present supply, with extensions, as best in quality and cheapest in cost. Next in order of quality are supplies from the Green River, South Fork of the Puyallup River, and from the Mashel River. In order of cost, the possible supplies stand as follows: Present or spring water supply, with extensions, $1,799,680; South Fork Puyallup River, $2,146,330; Mashel River, $2,235,520; Green River, $2,968,920. These figures do not include the cost of land and water rights. In the case of the present supply and proposed extensions, the figures include the estimated cost of all extensions, and an estimated valuation of such parts of the present works as could be utilized. All the other estimates include for distribution the estimated value of the present plant on the basis of the cost of duplicating it. The works of the Tacoma Light & Water Co. now have a daily capacity of 6,000,000 or 7,000,000 gallons, but are being enlarged to a capacity of 9,000,000. The value of the plant, after enlargement, is estimated by Mr. Hering at $884,650, not including land, water rights or value of franchise. The company's franchise is not exclusive; its contract with the city has already expired, and parts of the present works, according to the report, should eventually be abandoned.

The use of petroleum fuel for locomotives is said to be making little progress on the Argentine Great Western Ry., in the Argentine Republic, owing to the deficient supply of the mineral oil. This oil is also employed for producing gas for lighting the town of Mendoza, and even for this purpose the production is at present inadequate, so that the street lighting has had to be curtailed. San Rafael coal has been tried in small quantities on the same railway with excellent results, but the distance of the coal from the railway is so great that nothing more than experimental essays can be made. It has been proved, however, that the coal has a commercial value, although it is said to be improbable that it will be able to compete with imported coal, except in the western provinces, even if the mines are connected with the railway system of the country. It is stated that the introduction of wood fuel in some railways of the interior has been the cause of somewhat serious fires in trains, in one instance a saloon car taking fire and being burnt down to the iron frames. Cars of fire wood are also set on fire, and the frequent recurrence of casualties of this character would reduce the economies attributed to the use of wood fuel. Probably the best means of reducing the risks of fire from sparks would be the adoption of the American spark arrestor and extension smokebox for the wood-burning locomotives, but the risks will always remain greater than with coal burning engines.

A Chicago building of the present style of steel frame construction has come safely through a severe fire test. The nine-story fireproof building of the Chicago Athletic Club caught fire Oct. 31, and the fire was very hot, owing to the quantities of barrels and lumber in the lower floors, while the upper rooms were in the hands of the carpenters and plumbers. The following is the published statement of an official of the insurance patrol: "As far as we can see, the building itself is all right. The big girders are not bent, the brick floors are not broken and nothing has gone up but the slight brick partitions and the brick casing around the pillars. A few unimportant scantlings that held the partitions in place are bent and must be replaced. On the whole, the building is as sound as ever." The following remarks are credited to Mr. Charles Clark, the superintendent, who has represented Mr. Cobb, the architect, during the construction of the building: "I never knew a building stand fire so well in my life. Of course the lumber and stuff inside burnt, and everything being unfinished there was nothing to prevent the fire rushing from the bottom to the top. As to the stone front falling to pieces, there is no stone which will stand fire and water combined."

The powder to be used with our heavy guns and small arms is still undetermined, says Gen. Flagler, of the Ordnance Department, though type guns and carriages have been finally adopted, excepting only for the 16-in. gun. He says that suitable smokeless powder can be obtained for large and small guns, but he believes it is better to wait yet awhile and get the best, and have that best an American powder, if possible.

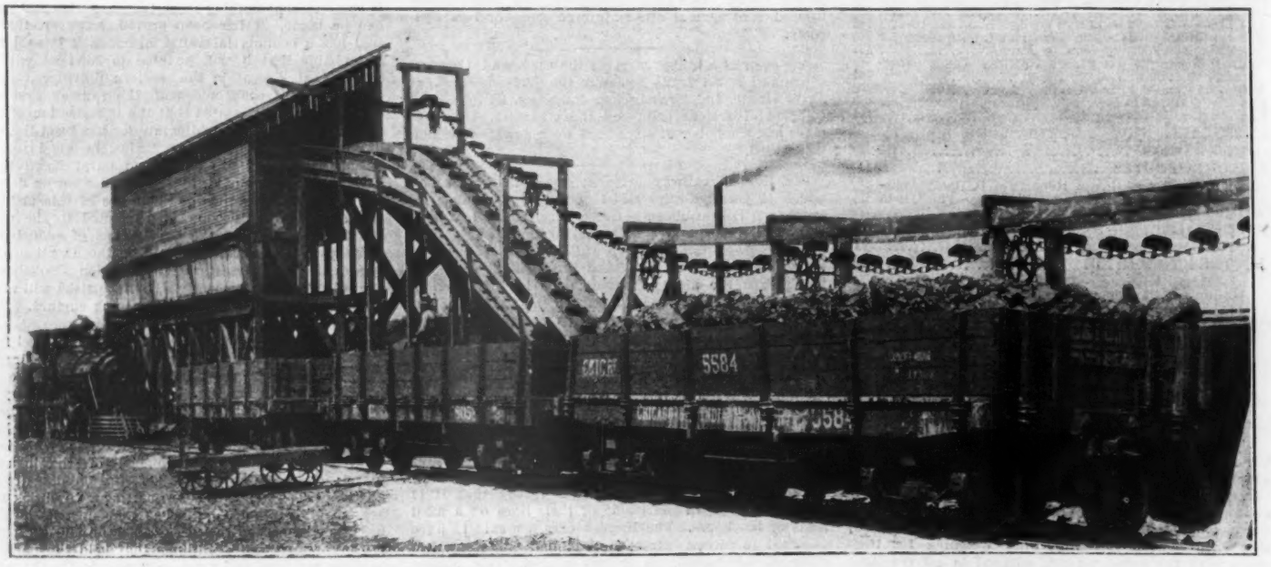
The Watervliet gun factory will be complete in its new equipment in less than two years. It will then have an annual capacity of twelve 8-in., fifteen 10-in., fifteen 12-in., and three 16-in. guns. The tests of the type guns continue to show a gratifying efficiency. The 12-in. gun at Sandy Hook has been subjected to pressures running as high as 28 tons per sq. in., and without injury. As to accuracy of fire, the following report speaks for itself: Range, one mile; vertical deviation from center of impact, 0.56 ft.; horizontal deviation, 0.56 ft. At a range of 3,000 yds., these deviations were 1 ft. and 1.75 ft. respectively. With the 8-in. gun, at one mile range, four out of five shots fired struck within an area of 20 by 21 ins. In a target of eight shots at 1¾ mile range, six shots struck in an area of 1½ by 4 ft. The 10-in. B. L. rifle shows similar accuracy. The 12-in. breech-loading, cast iron gun, tubed with steel, has been fired 228 times without corroding the bore by powder gases. The 12-in. breech-loading mortar, cast iron hooped with steel, is found satisfactory, and one of them has been fired 450 times without injury to the mortar. These mortars are made by the Builders' Iron Foundry, of Providence, R. I., and 73 of them are under contract. They were designed to throw a 630-lb. shell with a charge of 80 lbs. of powder. But as the decks of warships are increasing in thickness, another mortar has been designed with a 105-lb. charge and 800-lb. shell. Under a 2½-mile range 1,000-lb shells can be fired in both the hooped and the all steel mortars.

CONVEYOR PLANT AT THE COALING STATION AT NEW BUFFALO, MICH.: CHICAGO & WEST MICHIGAN RY.

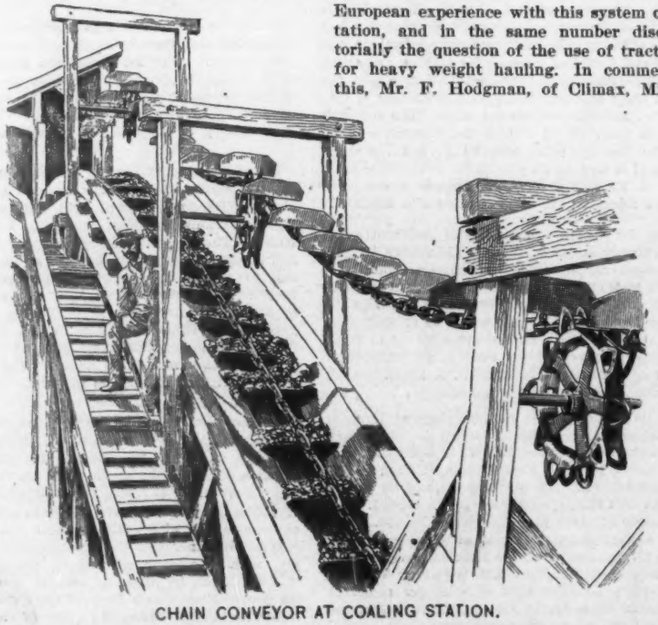
The handling of coal at coaling stations for locomotives is a matter of much importance on railways having a large traffic, and having to coal many locomotives a day. The application of machinery to this work not only facilitates the handling of the coal very materially, but also effects a considerable reduction in cost.

We illustrate this week the plant at the coaling station of the Chicago & West Michigan Ry. at New Buffalo, Mich. About 50 to 75 locomotives are coaled daily, requiring the handling of about 100 tons of coal, and the conveyor plant has a capacity of 120 tons per hour. The coal is bituminous. In ordinary service the coal is shoveled from the cars at the foot of the incline, onto the apron shown on the plan where it falls directly to the conveyor, and is carried to the coal pockets. If these pockets are full the coal is shoveled into a storage bin on the ground, with a capacity of about 600 tons. This bin is of timber, 130 ft. long, 14 ft. 3 ins. deep and 24 ft. 4 ins. wide on top, the sides sloping inward to a bottom width of 8 ft. Along the whole length of the bottom is a conveyor box 4 ft. wide and 2 ft. deep, covered with loose boards, and when the storage supply is to be drawn upon, some of these boards are removed, allowing the coal to fall into the conveyor box. The conveyor is about 9 ft. below the level of the top of the rail and from the end of the bin the conveyor rises at an angle of about 20° to the coaling shed, 80 ft. distant, where it is 26 ft. above the track on which the engines stand while coaling. Through the building, which is 60 ft. long, the conveyor passes above the coaling pockets from which the coal is discharged into the tenders. The building has ten coaling pockets. The pockets and chutes are built to a design patented by Mr. F. A. Susemihl, of the engineering department of the Michigan Central R. R., and their construction is very clearly shown in the accompanying drawings. There is a gate to each two pockets or chutes, and the coal is discharged into one or the other according to the position of the gate, which is hung to a vertical shaft the top of which is bent over to form a lever for moving the gate. Each pocket holds about 5 tons of coal, and has a balanced apron, which is pulled down by the fireman on the engine. The conveyor consists of a chain carrying steel scrapers or blades, which move in a steel lined trough. The chain is of the Dodge pattern, with links not directly in contact with each other, but having malleable iron wearing blocks, which prevent wear of the chain itself and can easily be renewed. In the carrying direction the blades are on the under side of the chain, which passes over a wheel at the end of the bin and the end of the building, the returning part of the chain being supported at intervals by sprocket wheels or idlers carried in overhead frames, as shown in the general view of the coaling station and the smaller detail view of the inclined portion of the conveyor. The conveyor is driven by a rope transmission arrangement, a manilla rope 1½ ins. diameter being used. This is placed a little distance beyond the end of the building, and drives the 36-in. wheel over which the chain passes at the end of its course.

The cost of handling coal at this station, as stated by Mr. J. J. McVean, Chief Engineer of the Chicago & Western Michigan Ry., is now about 6 cts. to 7 cts. per ton, while before this plant was put in the cost was 12 to 15 cts. per ton. This includes shoveling from the cars, drop bottom coal cars not being used to any extent in the West, as noted in the description of the standard coal car of the Chicago & Northwestern Ry. in our issue of Aug. 11. With drop bottom cars it is said the cost would be reduced to about 2 cts. per ton. Coal handling by cranes and buckets is said to cost 17 to 20 cts. per ton. The plant was put in by the Link Belt Machinery Co., of Chicago, and a number of similar plants, for handling anthracite, ashes, sand, etc., have been erected by this company. Mr. McVean states that the plant has worked very successfully and that it is the best arrangement he knows of for any place where large quantities of coal have to be placed upon locomotives, and that while its first cost is almost too expensive for small coaling stations, it is an economical arrangement for stations where 20 or more locomotives are to be coaled.



CONVEYOR PLANT AT THE COALING STATION AT NEW BUFFALO, MICH., CHICAGO & WEST MICHIGAN RY.



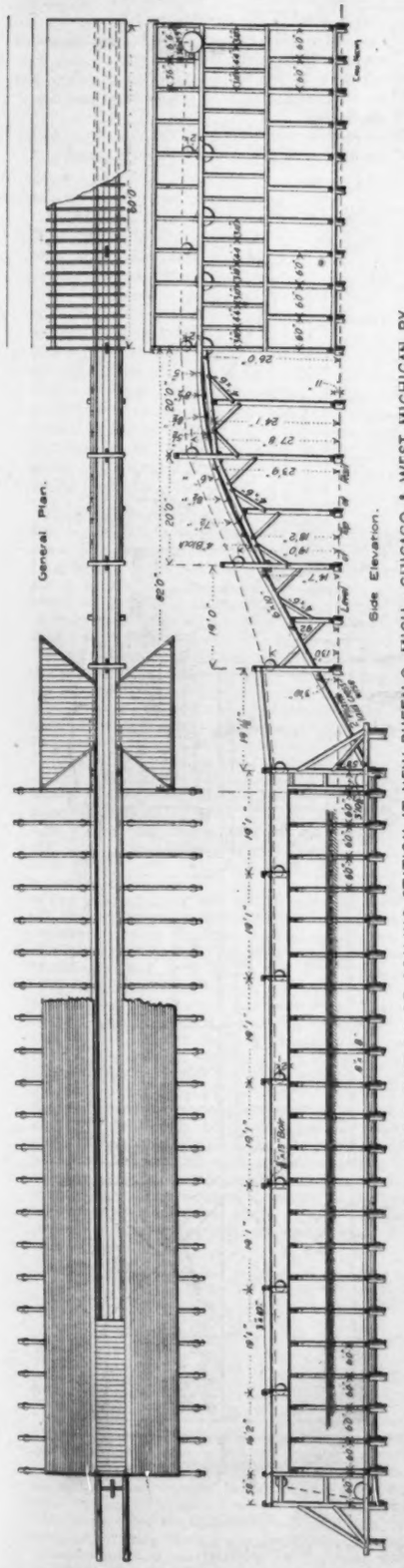
CHAIN CONVEYOR AT COALING STATION.

TRACTION ENGINES AND STEAM ROAD ROLLERS.

The use of traction engines for general transportation on the public highways is very limited in this country, as pointed out in the editorial in our issue of Oct. 27, in connection with the paper by Mr. Fletcher, in that issue, but these engines are used to a greater extent in the Western states than is generally understood. In our issue of April 4, 1891, we printed an abstract of a paper by Mr. John McLaren, on "Steam on Common Roads," giving details of the engines and of European experience with this system of transportation, and in the same number discussed editorially the question of the use of traction engines for heavy weight hauling. In commenting upon this, Mr. F. Hodgman, of Climax, Mich., stated (Eng. News, April 18, 1891) that traction engines were then in use to a considerable extent in this country, being mainly used in the wheat producing regions to furnish power for threshing machines. They are also used in Canada. Mr. Hodgman's letter continued as follows:

Nearly every township where wheat is a principal crop has one or more of these engines, which run the threshers, and haul them about from place to place.

They have entirely supplanted horse power for running threshing machines. When not in use for threshing they go about from place to place, furnishing power for various purposes, such as sawing wood, running light sawmills, etc. Very little hauling is done by them, other than the water tanks or machines which they are used to run, as that is about all the hauling it will pay to use them for. There are several firms in Michigan which turn out traction engines by the hundreds, yearly. At their first introduction there was much trouble from their frightening horses. That is mostly done away with now, as horses have become accustomed to them.



PLAN AND SIDE ELEVATION OF COALING STATION AT NEW BUFFALO, MICH.; CHICAGO & WEST MICHIGAN RY.

Some particulars of the use of traction engines in California for hauling logs and lumber as well as for plowing and other farm work were given in our issue of May 5, 1892. The engines referred to were built by the Daniel Best Agricultural Works, of San Leandro, Cal., and are built to run at a speed of about three miles an hour, hauling 50 to 75 tons over any ordinarily good road, and ascending grades of 5 to 9%. One of these engines in regular service made five trips per day, running 30 miles altogether, and hauling 14,000 to 16,000 ft. of logs each trip, at a cost 50% less than that of hauling by teams. The engines are of 50 HP. and cost $4,500, or $90 per HP. The above firm has built about 30 of these traction engines, one of which has been used for hauling gravel for street work at Sacramento, Cal., and another was sent to the Sandwich Islands, where it was used for plowing by day and for running an electric light plant by night. The fact that engines can be built to work successfully on the class of roads that prevail in the lumber districts seems to indicate that they can be built to run on ordinary highways in poor condition, though of course at a slow rate of speed. A traction engine for hauling circus cars was built some months ago (Eng. News, May 19, 1892) by the J. I. Case Machine Co., of Racine, Wis., builders of engines and farming machinery. The boiler was of the locomotive type, with a cylinder 8½ × 10 ins., driving by gearing the two rear wheels, which were 5 ft. 6 ins. diameter and 1 ft. 4 ins. wide. The two front wheels were 4 ft. diameter and 6 ins. wide, carried upon a swiveling axle by which the engine was steered. The weight of this engine was seven tons. A "combination" traction engine, which besides hauling can furnish power for pile driving, sawing wood, crushing stone, etc., like a portable or stationary engine, has recently been built by the Santa Cruz Engine & Boiler Works, of Santa Cruz, Cal. It has but one cylinder, and the driving wheels are 6 ft. diameter, with a face 14 ins. wide. It weighs 5½ tons and is said to be capable of hauling 12 to 15 tons at a speed of three miles per hour, or to run light at a speed of five to six miles per hour. These notes will serve to show that the use of traction engines has been found to be entirely practicable under severe conditions and service. The engines are principally intended for heavy work at slow speeds, but on better roads higher speeds could be attained, and Mr. McLaren's paper, above mentioned, referred to high speed engines for passenger traffic which have been successfully employed in France and India.

Steam road rollers may be classed with traction engines. They are largely used in this country, and are mainly similar in pattern to the ordinary type of portable and traction engines, having the cylinder mounted on a loco-tubular boiler. The following makes of steam rollers belong to this type: the Aveling & Porter roller, one of which fitted with compound engines, was illustrated in our issue of July 14, 1892; the Springfield roller, made by the O. S. Kelly Co., of Springfield, O., which was illustrated in our issue of Nov. 21, 1891, and the Harrisburg roller, made by the Harrisburg Foundry & Machine Works, Harrisburg, Pa. We have seen in London an Aveling & Porter steam roller used to haul a heavy "picker" for breaking up the old macadam paving on the Thames Embankment previous to laying a fresh top layer of macadam. The "picker" was a heavy iron block carried on small wheels and fitted with three knives, inclined forward, which cut furrows in the surface of the roadway to form a bond for the new paving material. For rolling new asphalt pavements, however, a lighter type of roller, of the Lindeloff pattern, with vertical boiler and cylinders, as illustrated in our issue of Aug. 9, 1879, is used in New York and Brooklyn. It is made exclusively by the Pioneer Iron Works, of Brooklyn, N. Y.

An American trade directory gives a list of 40 makers of traction engines, five of whom make straw burning engines, but the list is not complete. The same directory gives four makers of steam road rollers, but this list is also incomplete. It may be estimated that there are in this country between five and ten makers of steam road rollers, and between 40 and 50 makers of traction engines, many of whom are makers of general agricultural machinery and implements.

The work performed by road locomotives and horses, on roads either bad or of a very ordinary character, was contrasted in an official report which was issued by the Russian Government shortly after the Turco-Russian war. Thirteen traction engines of various makes were used in carrying ammunition and transporting cannon and other material at a number of points during that campaign. In the case of two road engines, working at Portables on the Franteshti-Zimnitz line, a detailed account was kept of their service and cost as compared with horses. One of these engines was at work for eight months and the other for two months. It was estimated that twelve of the engines, used for less than two years, not only completely reimbursed the purchase money and cost of maintenance, but also brought in a profit of over $5,300, as compared with the contractor's bids for similar work with horses. This resulted in spite of the fact that only some of the engines were used, and these only at short and irregular periods. Col. Demianovitch, who made the report stated that ordinary smiths made better drivers than men accustomed to railway locomotives, because the latter attempted to go too fast in spite of all orders. The report particularly commended this class of engine fitted with a crane at the front end, both for its ease in turning and general handiness in service, and for its ability to lift heavy loads with its crane. Col. Demianovitch stated that the Aveling & Porter engine with crane, of the pattern above referred to, could round sharp curves without slipping and could turn in a distance but little exceeding its own weight. The engine was intended for general hauling purposes, and the crane had a hoisting capacity of five tons and could be turned through a complete semicircle. With a light load of 11,000 to 15,000 lbs., the engine traveled at a speed of 4 to 4½ miles per hour. On macadam and good roads the engine easily pulled a load of 90,250 lbs., or about five times its own weight, with only half its ordinary pressure, and at a speed of 3.3 to 4 miles per hour. On country roads, a load not exceeding 1½ times the weight of the engine could be hauled. He found that the engine could ascend any grade accessible to ordinary carts, and with even greater facility than the carts. This engine, much improved in detail, was awarded a first prize gold medal at the Paris Exposition of 1889, and was illustrated in our issue of June 28, 1890. The use of traction engines fitted with cranes is referred to by Mr. Fletcher in his paper in another column.

The legal restrictions and regulations as to the use of traction engines on highways are very stringent in England, many old laws being still in force which are very harassing, but we learn from Mr. Fletcher that the question of securing the revision of the laws relating to this matter is under consideration by the Agricultural Engineers' Association, and that it is hoped to have them revised. On the other hand, Mr. John McLaren, member of the firm of J. & H. McLaren, which is one of the largest manufacturers of this class of machinery in England, and who is the author of the work on "Steam Locomotion on Common Roads," of which an abstract was published in our issue of April 4, 1891, has stated that while the present restrictions on this means of transportation are both hard and illiberal, he has come to the deliberate conclusion that life is too short to endeavor to get the laws amended. In spite of these drawbacks, too, there is a sufficient demand for the engines for Great Britain and the British colonies to keep his firm well employed, and under these circumstances there is of course no great inducement to devote time and trouble to securing the amendment of laws in a country like England, where all legal matters progress very slowly.

It is also reported that English builders of traction engines do not intend to exhibit largely at the World's Columbian Exposition, at Chicago, and Mr. Fletcher himself thinks that there will be few English engines exhibited. The protective tariffs of the United States make it practically impossible, it is said, for these firms to do business here, and there is consequently no inducement to incur heavy expense in sending their productions

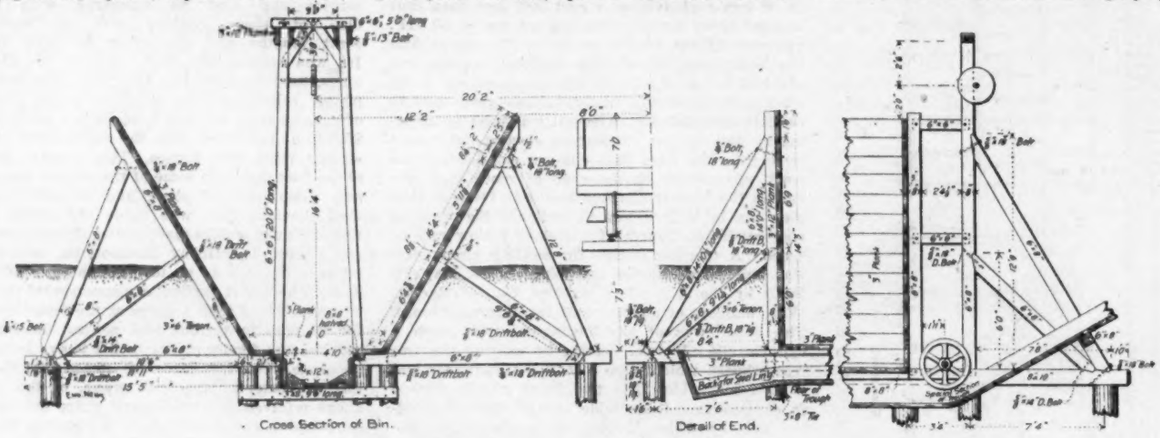
for exhibition. In view of the importance of the highway question, and the attention now being paid to highway improvement, it is to be hoped that American builders of traction engines will make a large and good exhibit of these machines for different classes of service.

THE SARGENT SMOKE PREVENTING APPARATUS.

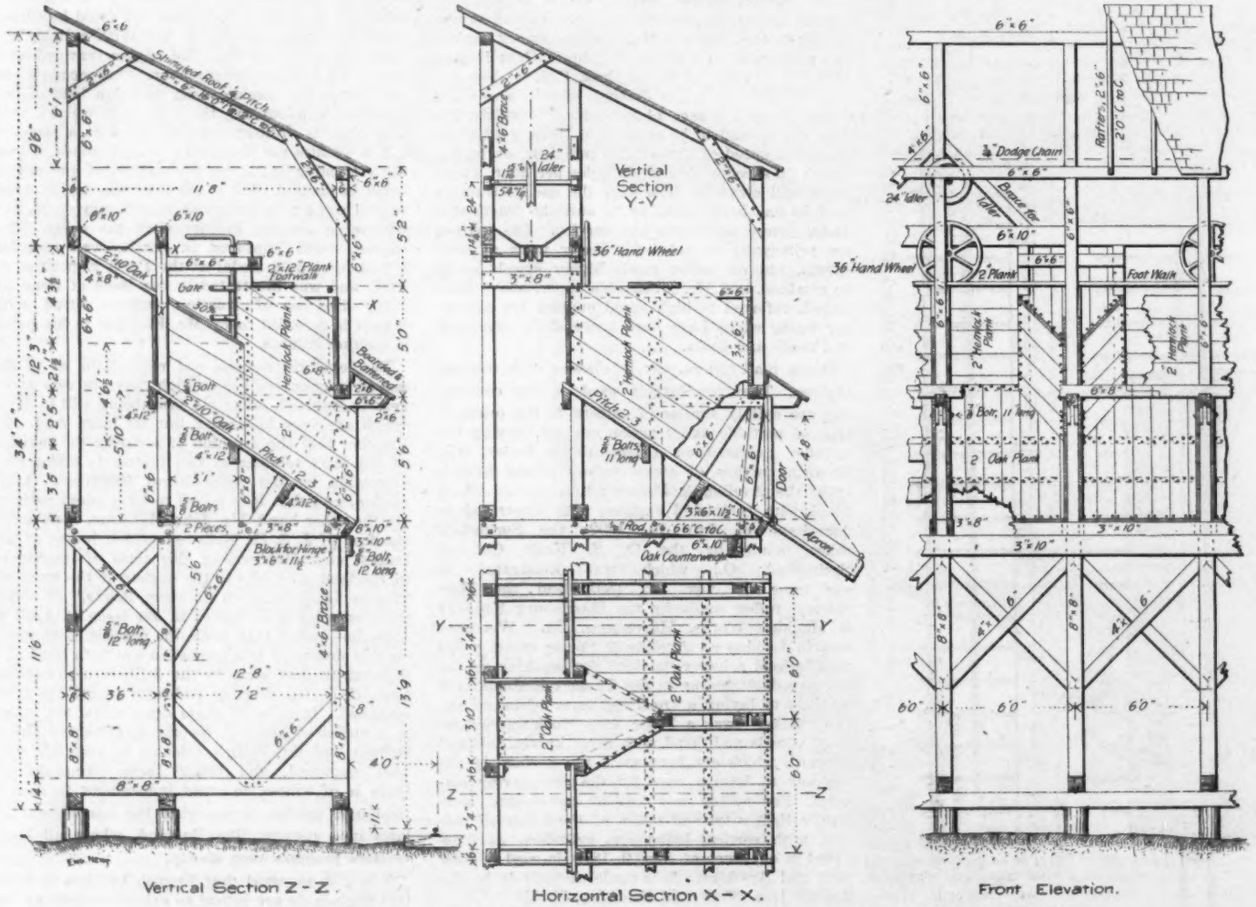
The question of preventing the smoke nuisance by adopting means to insure more perfect combustion of the fuel and gases has been discussed, and apparatus for this purpose illustrated, in our columns (Eng. News, April 4, Sept. 19 and Dec. 19, 1891; Feb. 27, March 26, June 30 and July 14 and 21, 1892). The general principle is that of the injection of steam and air into the firebox, and one system in which this principle is used, and which is said to have given excellent results in service, is that invented by Mr. John Sargent, inventor of the Sargent time lock, and manufactured by Sargent & Greenleaf, of Rochester, N. Y.

After the investigation and trial of various smoke consuming appliances, Mr. Sargent came to the conclusion that automatic control of a steam jet in conjunction with the introduction of an adequate volume of air, at the proper time, is the best means of effecting the desired end. An ingenious application of the principle of the time lock has been made by which the act of opening the furnace door for the purpose of supplying fresh fuel, winds a clock train set to run down in a given period of time, opens an air inlet and also the valve controling the admission of steam. The running down of the clockwork shuts the air inlet, together with the steam valve. The length of time for the clock to run is determined by the average firing of the furnace, and may be made to vary in summer and winter and from day to day or whenever there is any considerable variation in the demand for steam with its consequent demand for heavier firing. The apparatus may be attached in a few hours to any steam setting, without interference with its regular and continuous use. It is said to be durable and to require no more attention than any other fitting to the boiler or furnace. It is moderate in first cost and it is claimed that its use in the majority of cases will lead to an economy of fuel sufficient to pay for it in a short time.

Dry steam is conveyed from the top of the boiler and injected into the firebox through properly arranged jets with a special form of tip placed above the level of the fire door. In ordinary cases two tips will give the best results, although in some special cases a single jet will be sufficient, while in others, three or more may be used. The tip is



STORAGE BIN AT COALING STATION.



COALING SHED AND CHUTES AT COALING STATION AT NEW BUFFALO, MICH.; CHICAGO & WEST MICHIGAN RY.

so constructed as to distribute a thin sheet of steam moving with high velocity throughout the entire upper portion of the firebox. The steam jets enter the firebox above the air inlet, which is over the top of the fire doors, so that the current of air is carried into the furnace in a solid column, which, for a considerable portion of its journey from the boiler front to the bridge wall is mostly confined between the sheet of steam above it, and the live fire beneath. The entering air current quickly reaches the temperature of the incandescent coal beneath, so that by the time the current reaches the vicinity of the bridge wall it is in proper condition to produce, in conjunction with the steam, a complete combustion.

From tests made at Kimball's tobacco factory in June it appears that 2,433 lbs. of coal when burned with this apparatus in use supplied the fire 40 minutes longer than when the same quantity was burned without it, while 2,777 more lbs. of water were evaporated with this amount of coal when the apparatus was in use, and at the same time the steam pressure maintained 2 lbs. higher than when the apparatus was not in use. The gain in water evaporated per pound of coal burned when the apparatus was in use, was $8.88-7.33=1.55$ lbs. The following is an extract from a report made by Mr. George W. Rafter, M. Am. Soc. C. E., after tests made in October, 1892, at Sargent & Greenleaf's lock factory.

The steam boiler is an ordinary horizontal tube boiler, 5 ft. in diameter and 13 ft. in length, with 76 flues each 3 ins. internal diameter. The heating surface is about 1,020 sq. ft., while the grate area is about 25 sq. ft., giving a ratio of grate surface to heating surface of nearly 41 to 1. The coal used was Reynoldsville "run of the mine." The height of chimney is about 60 ft., with 4 sq. ft. area of flue. The feed water first passes through an Otis heater which receives the exhaust from the engine, after which it flows through pipes laid in the sides of the furnace before actually passing into the boiler at the flue line. The temperature of 192° as recorded in the table was taken after the feed water had passed through the heater and just before its delivery to the pipes in sides of furnace.

During Wednesday, Oct. 5, when the smoke preventer was not in operation, large quantities of smoke issued from the chimney for from three to five minutes after each firing, while during Thursday and Friday, Oct. 6 and 7, with the appliance in operation, the smoke was reduced to a mere nothing—none appearing except for a few moments at the time of firing. The difference in the labor of firing was also very noticeable. Without the smoke preventing apparatus the fire required considerably more attention, in order to keep the boiler pressure up to 80 lbs. Indeed during the morning of Wednesday, Oct. 5, it was found to be impossible to keep the steam pressure up without the assistance of a blower, the use of which has been discontinued since the steam jet was put in operation on this boiler.. This was probably due to the large demand for steam for heating the building. In the afternoon, however, with less demand for steam the plant was operated without the blower, although the labor of attending to the fire was greater than on the following days when the steam jet was used. On Wednesday the demand for steam during the first two or three hours of the day was about the same as on Thursday, nevertheless, with the steam jet in use under automatic control, no difficulty at all was experienced in keeping steam pressure up to, and even somewhat above, 80 lbs. The more important results of the tests are indicated in the following table:

	Appliance not operated. Oct. 5	Appliance in operation. Oct. 6.	Oct. 7.
	lbs.	lbs.	lbs.
Coal burned in 10 hrs.....	2,572	2,441	2,316
Water evap'd in 10 hrs.....	20,430	22,311	21,312
Water evap'd per lb. of coal...	7.94	9.14	9.20
Average boiler pressure.....	79.3	82.4	83.5
Temp. of feed water.....	192°	192°	192°
Temp. of air in boiler room....	80°	79°	81°

Referring to the table it appears that on Oct. 6, with the smoke preventer in use the amount of coal consumed was 131 lbs. less than on the previous day; while on Oct. 7, the decrease in coal consumption was 256 lbs. The water evaporation was, however, greater on both days when the apparatus was used than when it was not. Taking the increase in evaporation per pound of coal consumed we find that for the days when the apparatus was in use the increase amounted to 120 lbs. of water per lb. of coal on Thursday, and 1.26 lbs. on Friday.

The amount of steam actually passed into the furnace in order to produce the foregoing results amounted to about 600 lbs. for the 10 hours' run, as determined by computation from formula for discharge of steam through jets of the known size and for the time actually in use. It may be of interest to note that, had the steam jet been allowed to run continuously, as is usually the case when such jets are operated for this purpose, without automatic control, the amount of steam discharged into the furnace would have been at least 2,400 lbs. for the 10 hours' run. Without going elaborately into this part of the subject it will be sufficient to remark that the difference of 1,800 pounds of steam represents in this case the saving in use of steam by reason of automatic control.

Again, the use of the 600 lbs. of steam in the manner indicated led to such intensification of the combustion process, as to not only prevent the formation of any objectionable smoke but further increased the net useful effect of the fuel over 10%. There seems to be no reason therefore why you are not justified in claiming for the steam jet system as used at the lock factory not only successful smoke prevention but some saving in fuel as well.

ENGINEERING SCHOOLS OF THE UNITED STATES.

XXXI.

This brings us to a tabulation of the birthplaces of members shown in Table XXX., which we were able to supplement also by Table XXXI., showing the nationality of the parents of the members, or, in other words, their real racial nationality, independently of whether they chanced to be born on this side of the water or the other. The latter table is perhaps the most interesting. The two taken together show that of these 668 members reporting (of whom a good many are Canadian engineers) there are:

Born in U. S. of American parentage....	524 or	78.3%
" " Canadian, or foreign parentage.....	62 "	8.8%
Total American born.....	586 "	88.1%
Born in England, Wales or Scotland.....	18 or	2.7%
" " Ireland.....	11 "	1.7%
" " Scandinavia or Germany.....	29 "	4.3%
" " Canada.....	13 "	2.0%
Total.....	657 "	98.8%

This table may be said to represent the racial elements which are, so to speak, native to the blood, i. e., which are either native-born or out of the original racial stocks from which the English-speaking race was formed. The remaining 1.2% also (or only 8 members) are for the most part French or Russian. As such, this table again illustrates for the profession of engineering a truth to which we have often called attention and which is but little appreciated even at home, while foreigners usually ignore it altogether. In spite of the enormous emigration which has been pouring into this country for the last 40 years, the percentage of really foreign elements is as yet insignificant even in the whole population, still more in the higher employments, while the percentage of elements foreign to the blood is vastly smaller yet, and too trifling to consider. Under this latter head we should include chiefly the Italian and Slavic immigration, a considerable fraction of which makes excellent citizens, while a much larger number come to this country only to get means to end their lives at home on, and leave no descendants behind them. Nevertheless, this undesirable fraction of immigration from all countries should be checked; but there is no need of being alarmed about it, as if its specially bad qualities were likely to make any permanent impress upon our people.

By comparing the total of foreign-born members (79) with the number of graduates from foreign engineering schools given in Table XXVII. (45), it will be seen that the former far more than accounts for the number of engineers educated abroad; in other words there is absolutely no tendency even among students of foreign parentage, to go abroad for their engineering education. A good many, both natives and foreign-born (though a small percentage), take a post-graduate course abroad, but other than scholastic motives lead to that, and all post-graduate courses we have uniformly neglected in these records. It is quite certain that from now on no well informed man will ever go to a foreign engineering school with the idea that he can thereby get a better or more thorough education for a practical professional career than at home. It may or may not be a little more professional in the abstract; but in the practical work of training the qualities of mind which make the engineer, there is no reasonable room for doubt that our American engineering schools lead the world.

A curious proof of this is the insignificant proportion of Germans among the members of the Am. Soc. C. E. It is well known that the country is flooded with university-bred German draftsmen and assistant engineers. They are a trusted and most useful element in every considerable office and corps. There is no prejudice in their way in any part of the country. On the contrary, they do certain lines of work better than any other nationality and are sought for as assistants. They learn the language easily. They get very low pay at home and emigrate in large numbers. But where are they in the ranks of successful engineers

TABLE XXX.—Birthplaces of Members of the American Society of Civil Engineers (668 out of a total of 1,135).

Dates (inclusive).	No. years.	New England. M.	N. H.	Vt.	Mass.	Conn.	R. I.	Total.	Middle. N. Y.	Pa.	N. J.	Total.	No. C.	So. & S. W.	Far W.	Total U. S.	Eng. or Scot.	Ireland.	Scand. or Germ'y.	Brit. Am.	Other.	Not stated.	Total.
1867-9..	3	2	..	..	4	1	..	7	12	2	..	14	..	3	..	24	2	..	..	..	2	1	29
1870-4..	5	3	..	1	2	11	1	2	26	10	7	2	19	4	..	47	1	..	4	2	..	1	55
1875-9..	5	3	1	1	1	12	3	1	21	8	9	4	21	8	..	56	2	..	4	2	1	..	65
1880-4..	5	5	4	3	2	22	3	..	37	39	12	5	56	17	13	..	123	6	1	7	4	1	1	143
1885-9.	5	8	6	4		38	12	3	71	44	21	9	74	38	30	2	215	5	6	7	3	3	..	239
1890-2..	3	4	1	2		14	7	3	31	29	19	12	60	17	11	2	121	2	4	7	2	1	..	137
Totals.	26	25	13	12		101	27	9	187	142	70	32	244	84	67	4	586	18	11	29	1	8	3	668

Percentages.

	Mass.	N. E.	N. Y.	Pa.	Mid.	No. C.	So. & S. W.	U. S.	Eng.	Ir.	Sc.-G.	B. A.	Other.	Total.
1867-69. ..	14.3	..	25.0	42.9	..	50.0	..	10.7	..	85.7	7.1	..	..	7.2	..	100.0
1870-74. ..	29.4	..	37.1	18.6	..	35.2	7.4	7.4	..	87.1	1.8	..	7.4	3.7	..	100.0
1875-79. ..	18.5	..	32.3	12.3	13.8	32.3	12.3	9.3	..	86.2	3.1	..	6.1	3.1	1.5	..	107.0
1880-84. ..	15.5	..	28.0	27.5	8.5	29.4	12.0	9.2	..	86.6	4.2	0.7	5.0	2.8	0.7	..	100.0
1885-89. ..	15.9	..	29.7	18.6	8.8	31.0	15.9	12.6	0.8	90.0	2.1	2.5	2.9	1.3	1.2	..	100.0
1890-92. ..	10.2	..	22.6	21.7	13.9	43.8	12.4	8.0	1.5	88.3	1.5	2.9	5.1	1.5	0.7	..	100.
Mean.....	15.2	..	28.1	21.3	10.5	38.7	12.6	10.1	0.6	88.1	2.7	1.7	4.3	2.0	1.2	..	....
P. c. of U. S. only....	17.2	..	31.9	24.2	11.9	41.5	15.3	11.4	0.7	100.0	..	..	..	..	..	..	100.0

TABLE XXXI.—Nationality of the parents of Members of the American Society of Civil Engineers.

Dates (Inclusive).	No. yrs.	America.	England.	Scotland.	Ireland.	Scand. or Germany.	France.	Brit. Am.	Other.	Not stated.	Total.	P. c. Am.
1867-69.	3	22	2½	....	....	½	1½	1	½	1	29	78.7
1870-74.	5	44½	2½	3½	....	3½	..	..	1	....	55	80.9
1875-79.	5	51	1½	1½	½	6	1	1½	1½	½	65	79.1
1880-84.	5	112	10½	3½	3½	9½	....	1	2	....	143	79.5
1885-89.	5	187½	10	4½	9	17½	½	4½	3½	3	239	79.6
1890-92.	3	107	6½	2	3½	14	....	1½	3½	....	137	78.2
Total..		524	33½	15	16½	51	3	9½	9	6½	668	79.3
P. c....		79.3	5.1	2.3	2.5	7.7	0.4	1.4	1.3	....	100.0	....

In compiling this table the (comparatively very few) cases in which the parents of a member were of a different nationality were met by classifying the member as half of one nationality and half of another, hence the fractions.

Practically all those shown by this table to be native-born of native parents, nearly 80% of the whole, are Americans by many generations of descent, the reason being that prior to 40 or 50 years ago the emigration to this country was insignificant. A surprisingly large proportion of these members, upward of 150 in all, took the pains to say so.

who have enjoyed "responsible charge?" Nowhere! Of Swedes, Norwegians, Danes and Germans together there are only 29 members out of the 668 reporting or 4.3%, of which about 17 only, or 2½%, are Germans!

"We say not this to cry them down;" quite the contrary; but the fact deserves chronicle. A partial explanation may be that the German-speaking races have not as great aptitude for (practical) engineering as the English-speaking. History indicates that they have not; but another partial explanation may be defects of their engineering schools, which may tend to crush out executive and originating faculties and make their students mere mathematical machines.

The Irish in comparison have a much more creditable record, though their percentage (1.7) seems low. It is rather larger in proportion to the numbers to draw from than that of any other foreign nationality, even English or Canadian; and considering that there is only one apology for an engineering school in Ireland is far from bad. The English and Scotch make the most surprising small showing. Considering how their engineers swarm in the colonies it is surprising that there are not more among the successful men here. They have a perfectly fair field here; after a few years' residence few know them from Americans; but they have "no favor," as probably they do in the colonies.

As between the several states and sections of the United States the showing is somewhat surprising. It is to be remembered that the Am. Soc. C. E. membership represents only the engineers who began practice or study some 10 or more years ago, and is still semi-local in having a somewhat larger proportionate representation from the East than from the West. Still, it is a striking fact that, as shown by the last line of Table XXIX., not less than 31.9% of its members were born in the New England states (more than half of these from Massachusetts alone), while no less than 73.4% were born in the 10 New England or Middle states; the other 32 Southern and Western states having contributed only 26.6% all told. Future events are likely to change greatly these percentages, but they would hardly appear to be due to "local attraction" to any large extent. It is not clear why the Massachusetts or Pennsylvania engineer, not living in New York, has any greater inducement to join the Am. Soc. C. E. than one in the west or south, and the relative percentage for New England, New York and Pennsylvania indicates that not more than a quarter of the percentage for New York at most, or about 5% of the total, is due to the influence of "local attraction."

POLYTECHNIC COLLEGE OF PENNSYLVANIA.

Sir: I send you the following bit of information, which it seems to me should be in your possession, to make your account of the engineering schools in this country complete.

The "Polytechnic College of the State of Pennsylvania" was chartered in 1853, and from that time until some years after the close of the Civil War, nearly all the instruction in engineering, outside of West Point, was furnished by this institution or by the R. P. I. of Troy. For over two decades after its organization it grew steadily in favor, and its patrons came not only from our own country, but from sister republics in Central and South America, and from Mexico and the West Indies; graduating sometimes as many as 25. The attendance began to decline in the '70s, when a number of other technical schools were started, and a few years ago its doors were closed. On some of the great railways from the city of New York, a considerable number of the graduates of this school are engaged in some capacity or another, and not a few of these are occupying positions of great honor and responsibility, as one might properly infer from your Table XXVII.

You are not correct in suspecting that it had any connection with the University of Pennsylvania. The majority of the graduates of the Polytechnic College had received their degree before the University conferred any in Engineering. Yours truly,

Dan. Carhart, of the Class of '59.

Allegheny, Pa., Oct. 24, 1892.

THAYER SCHOOL OF ENGINEERING.

Prof. R. Fletcher calls our attention to the fact that the omission of Thayer School (No. 28) from our Table XXVII., giving the number of graduates from each engineering school (among 668 members reporting) who were members of the American Society of Civil Engineers, may lead to misconception, and sends us a list of 7 such members. The omission was due only to the fact that most of the members reporting specified simply "Dartmouth" and as the Thayer School is, to a large extent, a mere post-graduate school for the Chandler Scientific Department, and as we are taking no account of any of the post-graduate courses, it seemed fairer to omit the Thayer School altogether from this particular table.

UNIVERSITY OF ILLINOIS.

Sir: I desire to call your attention to two errors relating to this university in your article on engineering schools.

In Table XIX., page 210, the requirements for admission to the University of Illinois should include English Literature, Physiology and Rhetoric. Of course, the total would then be 11 instead of 8.

In Table XXII. and XXIII., page 288, the division of time for the civil engineering courses should be as follows:

Kind of work.	Exercises.	Weeks.	Per cent.
Recitation and lectures	1,750	92	64
Laboratory and drawing room	461	26	18
Field and shop	475	26	18
Totals	2,686	144	100

The unit of the first column is a class exercise, two to three hours in the laboratory, drawing room, field, or shop being considered as an equivalent of one hour in the recitation or lecture room. The total represents the minimum requirement for graduation.

I do not know from what source you derived the data for the tables, but if it was furnished by an officer of the University, it must have been under a misapprehension of your classification or terms.

Ira O. Baker,
Prof. C. E., Univ. Ill.

Champaign, Ill., Oct. 10, 1892.

(The figures given were a literal abstract from those formerly returned to us. The proper corrections will be made according to the above more correct figures.—Ed.)

UNIFORM PRACTICE IN PILE DRIVING.
III.

Mr. John C. Trautwine, Jr., after briefly commenting on the inherent difficulty of securing any precise formula of general application, presented the following discussion, an exceedingly valuable feature of which was a big list of actual records of the bearing power of piles:

The weight of ram and the height of fall may indeed be determined with reasonable exactness, and the product of these gives us, no doubt, quite approximately, the energy stored in the ram at the instant when it comes into contact with the head of the pile; but in estimating how much of this energy is utilized in driving the pile, we are obliged to remember that the mass of the pile has yet to be set in motion; that the direction of the blow can seldom be more than approximately in line with the axis of the pile; that the vibration of the pile under the blow will vary with the length of the pile projecting from the ground; that according to circumstances this vibration may facilitate or impede the driving, and that to an unknown extent; that the pile, even at its best estate, is more or less compressible, and that the head must become more or less crippled by the blows delivered upon it, thus further increasing and rendering still more uncertain the amount of the useless consumption of energy in the delivery of the blow.

But perhaps the most serious difficulty is encountered when we come to deduce the supporting power from the estimated effective energy of the blow, dividing the latter by a quantity containing the penetration a set per blow, as is done in all the formulas embraced in the present discussion. As observed by Mr. Rudolph Hering,* "the only method which can be depended on in calculating the sustaining power of piles held by friction, is the experimental one which introduces the actual distance (s) which a pile sinks under the last blow." And yet this very factor, the absence of which would render these formulas irrational and without which they would fall to the ground, constitutes at the same time, perhaps, their weakest point, especially in formulas which, like Major Sanders', have not a second additive quantity in the divisor. The penetration, as compared with the height of fall of the ram, is in most cases very small. The circumstances of actual practice seldom permit an accurate measurement, even of the apparent penetration, which again is always complicated to a considerable and uncertain extent by the compressibility of the pile and of the soil, and by the brooming of the head of the pile. And yet a very small error in the measurement or estimation of the penetration evidently causes a wide divergence in the results given by any formula in which this factor performs a prominent part.

Finally, we are almost entirely without experimental knowledge of the subject. All of the results I have been able to obtain in which the ultimate load is given or from which it may be inferred, are embraced in the handful mentioned below, and some of these (as explained in place) are of an exceedingly doubtful character.

But, the uncertainties of the case do not cease with the driving of the pile. Vibrations due to the load itself or to those upon neighboring structures, the lubricating effect of infiltrating streams of water, the reduction of pressure by the dredging away of material from adjoining works; these, and perhaps other causes, may operate to reduce the frictional resistance of the pile.

The author has earned the thanks of the profession by endeavoring to reduce the element of uncertainty attending pile-driving operations. He has done this by selecting that one of the existing formulas

$$\left(L = \frac{2wh}{s+1}\right)$$

which most commends itself to him by its simplicity and by its conformity to known principles, and has modified it by changing its divisor $(s+1)$, substituting first the expression $s+0.3$, and finally the expression $s+0.1+n+n'$, in which n = half the square root of the penetrations under a standard blow of 40,000 ft.-lbs., and n' serves the purpose of an additional factor of safety and varies from 0.1 to 1 according to the duty to be performed by the structure.

The five formulas discussed by Mr. Crowell may be written thus:*

Sanders:** $L = \frac{1}{6}\,\frac{12wh}{s}$ ***

Wellington: $L = \frac{1}{6}\,\frac{12wh}{s+1}$ ***

Crowell (a): $L = \frac{1}{6}\,\frac{12wh}{s+0.3}$ ***

Crowell (b): $L = \frac{1}{6}\,\frac{12wh}{s+0.1+\frac{1}{6}\sqrt{s\,\frac{40{,}000}{wh}}+n}$ ***

Trautwine: $L = (\frac{1}{6}\text{ to }\frac{1}{10})\,\frac{50w\sqrt[3]{h}}{s+1}$

in which, as in Mr. Crowell's paper,

L = the safe load on one pile;*
w = the weight of the ram;*
h = the height of the fall in feet;***
s = the penetration per blow under the final blows, in inches;***
n′ = a term varying from 0.1 to 1.

As thus written, the numerical fractional coefficient is the factor of safety, and the other factor is the extreme load R on one pile.

It will be noticed that there is a certain similarity of form existing between all of these formulas. All have in the numerator the product of the weight w of the ram by a function of the height h of fall, and in all but ours this function is the fall h itself. They thus agree in deducing, more or less directly, the work done from the energy stored in the ram, without making any definite provision for the inertia of the pile; resembling in this the simplest possible rational formula:

$$R = \frac{12wh}{s},$$

in which R is the resistance (assumed to be constant) of the earth to the penetration of the pile; in other words, the extreme load of the pile.

Like this very simple formula, also, all of those discussed contain in their denominators the penetration, s, of the pile under the last blow, or, as it is often put, the penetration per blow under the last few blows; but, in all except that of Major Sanders, the denominator contains a second term to be added to the penetration, and in Mr. Wellington's formula and our own this added term is simply 1 in.

Mr. Crowell refers to the use, in our formula, of the cube root of the fall as being theoretically illogical and practically inconvenient. Inconvenient it certainly is, as compared with the use of the fall itself, but I do not see that it is "theoretically illogical." On the contrary, so long as increase of height fall beyond moderate limits is found to be attended by increased losses of energy, it must be theoretically logical to make allowance for them, and the simplest if not the most rational way of doing this would seem to be, to represent the energy of the blow as varying with some power of the fall lower than the first.

Other things being equal, a high fall seems to cause a greater waste of energy in damaging the pile, and, as Mr. Wellington has pointed out, in rebounding of the ram, besides allowing a longer time for the material around the pile to re-compact itself.

McAlpine's experience at Brooklyn led him to believe that the supporting power of a pile varies as the square root of the fall.

* "Bearing piles." Published by Engineering News, 1878.

* L and w to be measured in one and the same unit, as both in pounds or both in tons.

** Mr. Crowell ascribes this formula to Weisbach, but I do not find it given by that author. It is given by Major John Sanders in the "Journal of the Franklin Institute," November, 1851, p. 304.

*** If h and s are taken in one and the same unit, as both in feet or both in inches, the number 12 disappears from the numerator of the first four formulas.

It can readily be shown that the large coefficient (50) necessitated by our use of the cube root gives excessive loads in cases of very low fall, such as may perhaps occur at times with the Nasmyth steam-hammer pile-driver. Thus, for a fall of only 1 ft., our $50\sqrt[3]{h}$ becomes 50h, and may thus give a load even much greater than

$$\frac{12wh}{s}$$

(see Fig. 2). For a 2,000-lb. hammer falling 1 ft., and producing 1.5 ins. penetration, our rule gives 40,000 lbs. as the extreme load, whereas the greatest theoretical extreme load)

$$\frac{12wh}{s}$$

is only 16,000 lbs. It may be proper to consider, however, that such cases hardly come within the actual probabilities of pile-driving, and these alone our formula was intended to cover. Indeed, I have no doubt it was constructed by its author as a rule of thumb by making it fit such experimental cases as came within his observation, and it is safe to assume that none like the one supposed were encountered by him.

Whatever may be thought of Mr. Wellington's demonstration of the correctness of the additive term 1 in the divisor of his formula and in that of ours, the omission in Sanders' formula of any such term must, I think, be regarded as a fatal defect, for it makes that formula give excessive loads for very small penetration, and infinite loads in cases where no penetration can be detected, and this no matter how light the ram or how low the fall. This, of course, is theoretically correct. A pile which undergoes absolutely no set under a blow from a falling feather will theoretically support the universe, but a formula which would make it do so in practice is hardly applicable to cases of very small penetration. It is but just to Major Sanders to note that in proposing this formula he limits its application to cases where the pile "meets such an uniform resistance as is indicated by slight and nearly equal penetrations for several successive blows of the ram." This rules out cases where the observed penetration is 0, but still admits those where the penetration is very small and where the safe load by the formula is therefore excessively great, as indicated in Fig. 1 herewith.

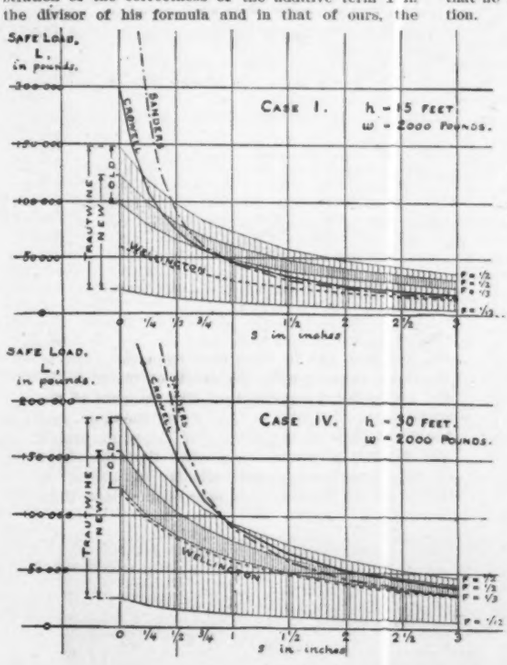


FIG. 1.

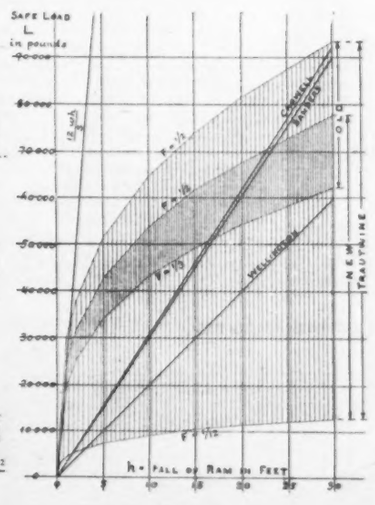


FIG. 2.

It has always been my impression that the "1" in the divisor of our formula was simply an empirical term used by the author to avoid the difficulty just referred to, and that he arrived at its value by trial with recorded cases.* Mr. Wellington's claim that it can be shown to be logically correct and a necessary factor in any rational formula, was, therefore, an agreeable surprise to me, and I have read with much interest his argument in the premises.

But, although I am naturally willing to be persuaded of the soundness of this position, I am obliged to confess that the perusal has not resulted in that firmness of conviction which could have been desired. It seems perfectly reasonable to assume that there is, as Mr. Wellington claims, an excess of resistance at the beginning of penetration; but we are not shown how the values of B'D and B'E in Mr. Wellington's Fig. 1 (B'E = 1 in., and B'D = 3.OB') are deduced from his observation of the behavior of piles, and from his experiments and study as to the laws of friction, and in the absence of this I am inclined rather to indorse his admission that the adoption of these values "is pure assumption, in the sense that we can never know experimentally, or at least, do not now know, just how this is."

Hence, I cannot join in Mr. Wellington's objection to Mr. Crowell's innovation in "tampering with the constant 1, and making it a variable." On the contrary it seems to me altogether probable that this term may, in fact, vary greatly (perhaps as much as from 0 to 2, 3 or 4 ins., or even more) with differences in the character of the soil and of the pile, or in the weight of ram and height of fall, and should, therefore, be made to appear as a variable in the formula. Indeed, if we had at command a sufficient assortment of reliable experimental data, I think we might be able, by modifying this term, to produce a more nearly serviceable formula than any yet presented. Mr. Crowell's proposed innovation, therefore, so far from being an unpardonable sin, seems to me to be an effort in the right direction, although a comparison of his results with the few experimental data at hand seems to indicate that he has not yet hit upon just the happiest combination.

It appears to me also, in view of "the excess in the coefficient of static friction, or of friction at very low velocities over that at relatively high velocities," that Mr. Wellington's diagram should show an increase of resistance toward the end of the penetration, where the pile is being brought to rest, and where, consequently, the velocity is rapidly decreasing. This final excess of resistance, would, no doubt, be less than the initial one (B'ED); but, such as it may be, it would seem sufficient to render us cautious in accepting implicitly an argument based upon the diagram without it.

Mr. Crowell, in his first suggested modification of Mr. Wellington's formula, proposes substituting 0.3 in place of 1.0 in the divisor. That this is an unfortunate deviation in the direction of Major Sanders' omission of any additive term, is indicated by my Fig. 1, where the curve representing this form of Mr. Crowell's formula is seen to mount very rapidly as the penetration becomes less than, say, 1 inch. Mr. Crowell's final formula, in which this term becomes

$$0.1 + \tfrac{1}{6}\sqrt{s\,\frac{40{,}00}{wh}},$$

suffers even more severely from this defect, for the additive term here diminishes with the penetration. While we may not unquestioningly accept Mr. Wellington's argument in behalf of the constant value "1" for this term, these considerations certainly indicate that it is, at least, safer than Mr. Crowell's proposed modifications.

I am inclined to question the propriety of allowing the factor n to be determined by means of a standard blow of 40,000 ft.-lbs., as in Mr. Crowell's formula, without restriction as to weight of ram or height of fall. It sometimes happens that a pile refuses under a light ram with high fall, but moves satisfactorily with a heavy ram and low fall, and sometimes the reverse of this obtains, perhaps, chiefly in cases where a hard and shallow stratum is encountered.

It will be noticed that in all the formulas, except Mr. Crowell's (b) and our own, the value of the factor of safety is fixed. In ours "not more than one-half the extreme load" is to be taken "for piles thoroughly driven in firm soils, nor more than one-sixth when in river mud or marsh"; while, if there is liability to tremors, only one-fourth and one-twelfth of the extreme load are to be taken respectively. Mr. Crowell has undertaken to provide, in addition to his fixed factor of safety of one-sixth, a sliding scale for the term n' in the divisor of his formula, whereby that term is given a series of fourteen different values, depending upon the service for which the superstructure is to be used and upon the exposure to which it is to be subjected.

In view of the great diversity of the conditions under which piles are driven and of those under which they are subsequently employed, I cannot but think it better to have an elastic factor of safety rather than one which remains the same whether the superstructure is to be on the one hand a lumber yard or a mausoleum, or, on the other hand, a trestle or a draw-span to be used by trains of all descriptions.

It would appear, therefore, most desirable to provide a series of factors for safety, arranged, like Mr. Crowell's, to suit the various conditions of service; but, until the experimental data at our command become vastly more numerous and more reliable than they now are, any such table must, as already intimated, be taken, like the "1" in the divisors of Mr. Wellington's formula and of our own, as a "pure assumption." In the present state of our ignorance, much must be left to the judgment of the engineer, and he may well be thankful if we succeed in concocting a rule of thumb which gives results bearing some sort of proportion to the probable extreme load, leaving it to him to decide what portion of this load he will take his chances with.

Comparing, then, the Trautwine formula as it appeared in the first and later editions, we find that in the former we have : Extreme load in pounds =

$$\frac{60 \times \text{weight of ram in pounds} \times \sqrt{\text{fall in feet}}}{\text{penetration in inches} + 1}$$

with factors of safety from one-half to one-third, and that in the later editions the coefficient has become 50 and the factor of safety from one-half to one-twelfth.

Hence, Mr. Crowell's presentation of our formulas in this Diagram 2, while correct as far as it goes, is not sufficiently comprehensive to represent our formula properly, for his upper curve represents it with a coefficient of 60, and a factor of one-half, while the lower one represents it with a coefficient of 50 and a factor of one-third. A satisfactory showing would require, in each of his four diagrams, at least four curves for our formulas, viz., two with a coefficient of 60, one of them with a factor of one-half, the other with a factor of one-third; and two with a coefficient of 50, one of them with a factor of one-half, and the other with a factor of one-twelfth, and I therefore submit herewith (Fig. 1) diagrams for his two extreme cases, I. and IV. (h = 15 ft., and h = 30 ft., respectively), drawn in accordance with this suggestion.

In these diagrams I have used lines of the same characters as those used by Mr. Crowell, to designate the Sanders, the Wellington and the Crowell (a) formulas, respectively, each of which, allowing no latitude as to the coefficient of safety, is properly represented by a single curved line, while our formula, in its two forms, each with a variable factor of safety, is properly represented by shaded areas.

These diagrams show clearly the defect of the Sanders formula, already referred to, the allowed load rapidly approaching infinity as the observed penetration falls below three-fourths and one-half inch, and they also indicate, I think, that Mr. Crowell's proposed substitution (a), of 0.3 for 1.0 in Mr. Wellington's formula, errs in the same direction.

The resemblance between Mr. Wellington's formula and our own is shown by these diagrams, each of which represents a constant height h of fall; Mr. Wellington's formula falling well within the very wide area embraced between the limits of our later form, and necessarily partaking of its character. But lest it might be hastily assumed, in view of this, that Mr. Wellington's formula was but an imitation of ours, I submit also a second diagram, Fig. 2, in which the penetration s (assumed at 1 in.) is supposed to be constant, while the fall h is made to vary.

Plotted in this way, the formulas of Sanders, Welling-

* In presenting his formula, he remarked: "Although this is all wretchedly empirical, it certainly appears to accord moderately well with such facts as we have been able to obtain. Like other rules of this kind, however, it should be used with caution; and with a wide margin for safety in important cases."

*Inasmuch as the term n' of Mr. Crowell's final formula serves the purpose of a factor of safety, and varies according to an arbitrary scale, with the use to which the superstructure is to be put, it should not, I think, be included here.

ton and Crowell (a) are necessarily straight-line formulas, as is also the theoretical formula.

$$\text{Extreme load} = \frac{12\,wh}{s}$$

which I have added here for comparison; while our formula, of course, appears as a curve determined by the presence of the cube root of h in its divisor. It will be seen that with a penetration of 1 in. Mr. Crowell's formula (a) gives results almost identical with those of Major Sanders' formula. This diagram exhibits also the fact, already noticed, that our formula, owing to its employing the cube root of the fall, gives excessive loads for very low falls.

It is an ominous fact that neither Mr. Hering, in his pamphlet, already quoted, nor the author, in the present paper, brings forward any results of experiments in support or in refutation of any of the formulas; ominous because it indicates the dearth of such results. For years I have been on the lookout for data of this kind; but the result, as embodied in the following table, is discouraging in the extreme. I cordially second the hope of the author, "that in the discussion which this paper may call out, practical examples will be given, taken from the actual behavior of piles in service, under loads of various character."

When only the actual safe load is given, we are left in doubt as to how much the pile would safely bear. Hence, I have restricted my list of results chiefly to those which give, or from which we may infer, the ultimate or extreme load which causes settlement of the pile, and which our author rather unfortunately calls "the sustaining power" of the pile. I have omitted cases where the piles are known to have failed by being pushed over laterally by the pressure of adjoining arches, or through similar causes other than the vertical pressure of the load upon their heads.

Mr. Trautwine then gives many pages of detailed records of bearing powers, which we shall abstract later in different form. The remaining discussions contributing new facts to the record were as follows, omitting parts of the discussions not relating to those facts.

(To be continued.)

THE FLOW OF THICK SHEETS OF WATER OVER DAMS.

By Clemens Herschel, M. Am. Soc. C. E.

The article by Mr. Joseph P. Frizell published in Engineering News of Sept. 29, awakened within me the recollection of an experience which may prove of interest to the profession, as bearing on the correctness of the diagram submitted by Mr. J. T. Fanning, and shown in that article.

Some years ago I became specifically interested in the form which a thick sheet of water flowing over a dam would assume, just down stream from the crest of the dam, and, wishing to acquire at least some knowledge on the subject, I took the pains to make a few measurements of the exterior form of the sheet referred to.

At Turner's Falls on the Connecticut River, there is a wooden dam which, becoming unstable at one point, was strengthened at that point by a little pier built just down stream from the dam; rectangular in plan, and forming a sloping apron, in front of the dam, in side elevation. This permits the exterior form of the sheet of water passing the crest of the main portion of the dam to be seen from the shore, projected against this side elevation of the above mentioned pier. I did this, and by means of ranges on shore, of a ruling point of the form of the sheet as lined in against this same pier, and of their results as measured on the pier after the water, the next summer, had left the dam dry, I constructed the diagram, herewith inclosed (Fig. 1).

I also inclose a photograph (Fig. 3) of the same sheet of water on this dam, which was taken at a time when the gage registered 8 ft. 7 ins. on the dam.

For some reason (as any close observer can see for himself from the photograph), there is less horizontal projection to such thick sheets of water, than pardonable or even apparently rational assumptions, placed at the start of a theoretical computation of these cases, would produce at its further end. Take the falls of Niagara, for instance, whose general effect or impression produced is certainly that of a vertical curtain of water, not that of a spouting stream; and take also the diagram and photograph just referred to.

The office of historian is proverbially easier to fulfill than that of a prophet; but I also send you my idea of how the water would look coming over Mr. Frizell's dam in a sheet nominally 15 ft. thick, drawn as well as my present acquired study and observation would lead me to picture it. Needless to say that it is only a sketch, and that it makes no pretense to precision of dimensions. These last could be gained only by measurements of the thing itself. The sketch is shown in Fig. 3.

Further contributions of facts would naturally prove of material interest to hydraulic engineers.

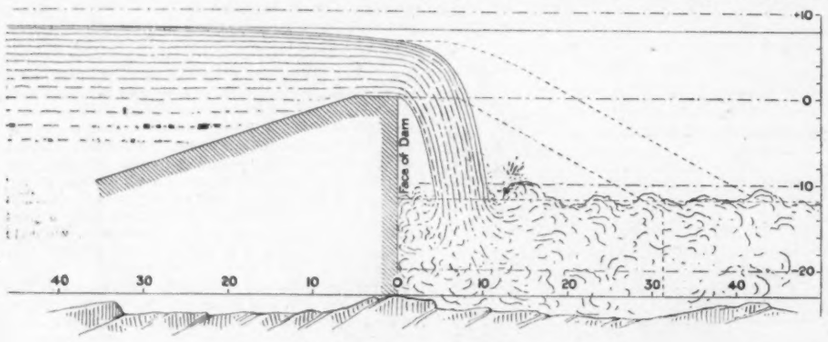


FIG. 1. CROSS SECTION OF TURNER'S FALLS DAM.

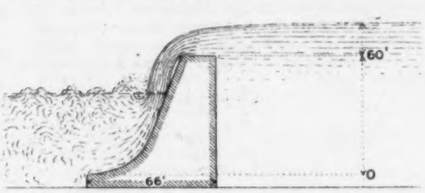


Fig. 3. Sketch Showing Section of Austin Dam with 15 Ft. of Water Flowing Over It.

a superficial observer would suppose. See on this point the figure on p. 112 of Hamilton Smith's "Hydraulics," giving the results of actual measurements, and here reproduced (Fig. 4). This shows the curvature of the surface to commence more than 50 ft. up-stream, for a gage reading of only 7.27 ft., "on the dam." In line of the crest, the sheet of water was only 5.2 ft. thick. Merriman's "Treatise on Hydraulics" gives a formula for finding the drop of the water surface immediately at the crest, whose results agree fairly well with the measurements, for the case just cited.

With the curvature of the surface commencing 50, 100, and 150 ft. up-stream from the crest of the dam, varying with the depth of water on it, and producing a depression of 30% or more of the static depth at a point vertically over the crest, and the great slope of the surface of the water which this in turn produces, no wonder that the sheet of water assumes a perpendicular outline much nearer to the down-stream face of the dam, than

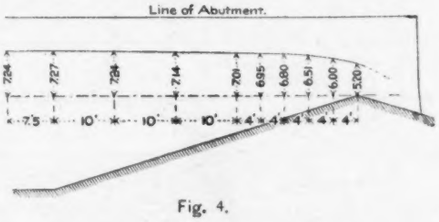


Fig. 4.

FIG. 2. VIEW OF DAM AT TURNER'S FALLS, MASS.

(Water 8 ft. 7 ins. deep on dam.)

Meantime, attention may be called to the circumstance that the effect of a vertical overfall is felt at a much greater distance up-stream from the crest of the dam than the grist of erroneous yet pardonable, or even of general acceptable, assumptions, put into the hopper of divers computations, would fain make us believe.

FAILURES IN THE NECKS OF CHILLED IRON ROLLS.*

During the last 30 years great improvements have been effected in the machinery for rolling heavy iron and steel plates. This has reduced the cost of production, and has enabled us to compete successfully with foreign makers, whose labor is less costly than ours. The ponderous gearing, which at one time occupied so much space, and was a source of great expense, has given way to direct driving. Three high rolls and hydraulic tables have been introduced; in fact, our modern rolling mill is different in every way from that of the past, with the exception of the chilled iron rolls, which have to do all the work. These seem to have had very little attention paid them, and the cause of any failure has been put down to inferior material, which in many cases may be true. Steel rolls have been adopted in place of cast iron for cogging (breaking down blooms), and also in the large plate mills, where finish and accuracy is not so important as safety; but where a good face and accurate gage is required, chilled iron stands firm against all attempts to displace it.

Many methods have been tried to improve the working qualities of the rolls, and there is still very much to be accomplished; but the only real improvement that has yet been successfully carried into effect is that of keeping the rolls cool by a copious supply of tepid water, without which it would be impossible to prevent disaster owing to the quick succession of hot blooms, which is nearly equal to the effect of a furnace. When we consider that the output for one pair of rolls was formerly only about 150 tons per week, and now is from 900 to 1,000 tons, it is obvious that some provision must be made to accomplish the extra work. In many sheet mills, indeed, there are no means whereby the temperature may be kept down in the body of the roll, which rises to that of oxidation; but although the cooling of the body is not attempted, a good supply of water is often provided to keep the necks as cool as possible, so that the lubricant may not burn off, or the brasses cut. The consequence is that an unusual expansion takes place in the body and the neck, and though the effect does not show itself at once, yet a weakening process has been set up which will eventually shorten the life of the roll, for a failure is certain, sooner or later, to take place if not provided against by a suitable design. By proper designing, the temperature of the roll may be gradually reduced, so that the atoms of the iron at the junction of the body and neck of the roll are not subjected to a disturbing or disorganizing influence.

Some years ago my attention was drawn to certain difficulties in connection with the chilled rolls used in the tin plate trade in South Wales, and what made the matter difficult to solve was the fact that while most of our friends down there were well satisfied with the rolls in every way, a few had a great deal of trouble. Now, the material of which the rolls were made was identical in each case, and the work they had to do was in all cases the same, but the results were extremely variable. Having suspicions that the fault lay in the design, drawings were prepared of all rolls sent into that district, which showed that those which were satisfactory were different in design to those that failed during their work, and the appearance of the fracture in the broken roll clearly showed the temperature of the neck and the roll to have been quite different. The metal of the body had turned a dark blue color owing to oxidation, and the fracture of the neck had remained perfectly bright, having, however, a ragged appearance, the metal in many cases hanging away from the face of the fracture as though torn away by great force.

Now, it is worthy of note that all chilled rolls used in this branch of trade for hot rolling require an abnormally large diameter of necks; for instance, a roll having a diameter of 19 ins. is never safe unless it has a neck of 14 ins. diameter; but a similar roll for cold rolling is perfectly safe with a neck having a diameter of only 12 ins.—in fact, a breakage of such a roll used for cold rolling has not at any time been reported to me; yet the pressure upon the bearings is about equal in both cases, so that the only conclusion one can draw is that the weakness has been caused in the hot roll by the unequal expansion of the body and the neck.

Some time ago a report was given in one of the iron trade journals of a bankruptcy case, near Birmingham, when the bankrupt stated one of the causes of his failure to have been loss by broken rolls, and gave an estimate of £2,600 ($12,630), for that item. Being unaware of the nature of the breakages, and having had nothing to do with this particular house, I can only conclude that there must have been want of care somewhere.

An application was made to me some few years ago to supply a set of three grain rolls for cogging down billets for wire rods. It was pointed out by my friends that they had tried many roll makers, but the result was always the same, and the neck at the leading gate end always came off after a certain period of work. It is not, therefore, surprising that a similar result happened in my own case. At the time, the case appeared to be unaccountable, but the experience that has been gained since then convinces me that the failure was entirely due to the unequal expansion of the neck and body, for the leading gate was very close to the end of the roll (a mistake which is often made), thereby causing the end of the roll to be greatly heated near the junction of the neck, which was kept cool by means of a copious supply of cold water.

Another interesting case occurred about the same time, where the diameter of the necks of a pair of chilled rolls were reduced to save power; the area of the bearings was maintained, and the result up to a certain time was so satisfactory that the proprietor of the mill decided to adopt the smaller necks in the future, thinking he had given the rolls a fair trial after having run them about a month or five weeks. It was found, however, that we had been a little hasty in drawing our conclusions, and our plans were seriously interrupted by the necks breaking off. On examination, the fracture displayed a dark ring, which subsequent experience proved to be the result of an unequal expansion of the body and neck, although at first it was put down to a faulty casting, having that appearance. Had it been so, however, a failure would have taken place much earlier. Evidently, a rupture was set up on the periphery of the neck, and by frequent heating and cooling the molecular construction was disturbed, which caused the fracture to travel toward the center, until the remaining portion became too weak to resist the work put upon it.

Continental mill owners do not appear to suffer from the failure of roll necks so much as some of our mills at home; but the difference, however, is not sufficient at home. It may be that we in England make our rolls do much more work than they do on the Continent.

In the event of a breakage of a roll, the diameter of the neck is often looked upon as the sole cause of mischief, and consequently, it is in many cases increased. Trouble of this kind has been overcome by these means; but it appears to me that it is a very unscientific mode of procedure, and that bringing the neck up toward the diameter of the body is assisting to bring about another evil by conducting the heat to a place where it is not wanted. Longitudinal cracks upon the face of the necks are evidence of overheating. Increasing the diameter of the necks also considerably increases the friction, particularly if the necks burn off the lubricant. Larger radii for the ends of the roll without increasing the diameter of the necks reduce the diameter and temperature gradually, thereby allowing the neck to be kept cool without causing a movement of the molecules of the iron at the junction of the neck and body.

Before closing my paper, and in order to substantiate my views upon this question, let me ask you to consider the fact that the failure of the necks of chilled plate rolls often takes place after a considerable period of working. Sometimes they occur soon after being put to work; but as the failure in those cases is attributable to some specific cause other than that which we have before us, we must leave such failures out of our consideration. Taking the generality of rolls which may work two, three, or more months before failure, the fact that they have worked so long sufficiently proves that they are strong enough to resist the ordinary strains put upon them in the process of rolling, and that the failure is due to long continued strain, causing a final rupture at the juncture of the neck and body.

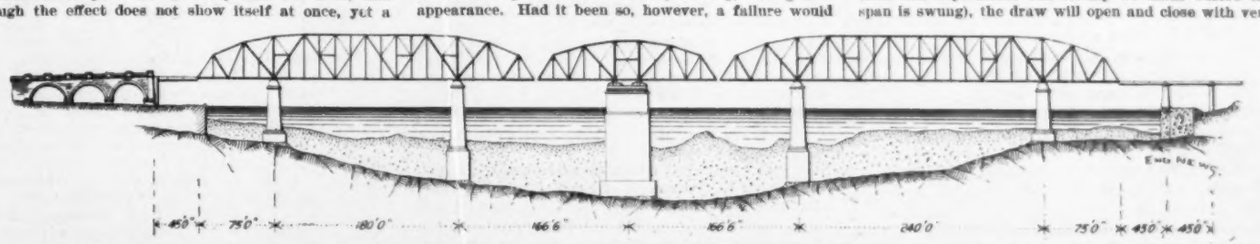
* Condensed from a paper by Charles A. Winder, read at the Liverpool meeting of the Iron & Steel Institute.

CANTILEVER SUPPORTS FOR A SWING SPAN.

The accompanying diagram shows in outline an ingenious design for a drawbridge which was prepared by Mr. Alfred D. Ottewell, M. Am. Soc. C. E., for the Darling Harbor bridge competition, described in our issue of Sept. 29.

The channel to be crossed had about 80 ft. depth of water and silt over the rock at its deepest part, where a swing span with two 60 ft. openings had to be located. As seen by the accompanying profile, if piers had been placed at each end of the swing span, according to the usual practice, there would have been three piers in the deepest part of the channel. By supporting the ends of the swing span on cantilever arms projecting from the main span, Mr. Ottewell was enabled to locate the piers on higher parts of the rock and economize considerably in their cost. The following, quoted from the memoranda submitted by Mr. Ottewell with his design, explains other meritorious features of this method of construction.

As the clear opening on each side of swing pier is 60 ft., and as the piers are very costly, it will not be economical to rest the end of the draw span directly upon a masonry pier as is usually the case. This is one of the reasons for supporting part of the live load on the draw span on the ends of cantilever arms as proposed. Another reason for this proposition is that it avoids the trouble often experienced in opening and closing draws due to the greater expansion of the top chords and web members than of the bottom chord, the former being more exposed to the direct rays of the sun than the latter. For it is obvious that the draw rest will be lowered from the above cause as much as the draw itself, and hence when once properly adjusted (and this adjustment can readily be made before the span is swung), the draw will open and close with very



OUTLINE ELEVATION OF DRAWBRIDGE; DESIGNED BY A. D. OTTEWELL, M. AM. SOC. C. E., FOR DARLING HARBOR BRIDGE COMPETITION.

great ease. In fact it seems to the author that this is the natural way of supporting a draw. For when the draw is to be opened, teams which have just left it will, to the extent of their weight, reduce the pressure of draw on the draw rest, and hence increase the ease in opening. When the draw is being closed, teams are waiting on the draw rest to cross, and for the same reason will assist in the closing. The ends of the channel cantilevers will be protected by four clusters of piles.

STREET CLEANING IN PHILADELPHIA IN 1891.

The total expenditures of the Philadelphia Bureau of Street Cleaning in 1891, according to the report of Chief S. H. Martin, were $559,728. Of this sum $9,220 was paid in salaries to the officials; $2,400 for the keeping of horses and wagons for the chief and five inspectors; $300 for printing, stationery and incidentals; $547,808 for cleaning streets, removing ashes and garbage.

The total area cleaned during the year was 709,375 squares, measuring about 500 ft. in length by an average of 26 ft. in width.

Thus a square contains about 13,000 sq. ft. and the total area cleaned in square feet was 9,222,875,000. In addition 240,546 sewer inlets were cleaned; 36,153 crossings, in January to April, inclusive; 1,840 markets; and snow from 54 fire plugs. These figures, of course, are stated in terms of one cleaning.

The loads of refuse removed during the year were 290,680 of dirt; 573,999 of ashes; 84,065 of garbage; total, 948,744 loads. In addition 14,795 dead animals were removed.

The work of the department was done by five contractors, each having a separate district, and using street cleaning machines. These contractors bid $89,000 extra on the basis of burning the gar-

bage, they to erect furnaces, but their bids for this service were not accepted. One firm, however, bid $12,000 per district for burning the garbage, or $60,000 for the whole city.

Frequency of cleaning varied from machine sweeping daily with a day broom patrol in addition to only once a month. All sewer inlets were cleaned at least twice a week, where the streets were cleaned that often, and all others once a week. All public market houses were swept once a day and when the thermometer was above the freezing point they were scrubbed with water at least twice each week. All the accepted streets in the city were cleaned. The refuse was all dumped, but the length of haul is not stated. Mr. J. H. Windrim is Director of Public Works.

PORTLAND CEMENT PACKING RINGS.

A correspondent of the "Papier Zeitung" mentions that a Mr. Adolph, of Mayence, is putting upon the market packing rings made of cotton tubing filled with Portland cement. These rings are in various sizes to suit different needs, and are used for making joints in manholes, flanges, etc., by wetting them thoroughly, putting them in place and screwing up with a uniform pressure over the whole circumference. This packing is said to be tight under ordinary pressure, and the joint can be readily parted when required. The first cost is exceedingly small as compared with rubber, and the user can afford to put in a new ring each time the joint is broken.

The "Papier Zeitung" prefers joints made with the cement alone, especially when the joint is to be permanent. As described, the cement is mixed with water to a stiff paste, the joint is cleaned of oil or grease and the cement is applied in a layer 1-5 to 1/8 in. thick, depending upon the diameter of the flange and weight of the cover. The cover is then carefully laid on, seeing that no gaps are left, and the joint is screwed up cautiously, each nut or bolt being given a few turns at a time. When the cement has been screwed down to say, 1/8-in. thickness of joint, it is allowed to set for four to six hours and then screwed up again. The edges of the joint are then plastered with fresh cement and wiped off with a wet cloth or a brush a few hours after.

A joint thus made is ready to withstand pressure in six or eight hours and costs about one-twentieth of one made with rubber, or one-tenth of one made with asbestos and tallow. In the case of steam-pipes, where some elasticity is desirable, this can be secured by using the cement thinner, say 1-26th in., and inserting a ring of absorbent paper previously well wetted.

These joints are perfectly tight after three months' use, and have proved satisfactory for water and hot-air pipes, and even for cylinder covers, says the "Zeitung." The only drawback seems to be the innate prejudice of the workmen to properly use them. In this connection we would refer our readers to some correspondence in our issue of July 14, 1892.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Railways Must Maintain Farm Crossings in New York.

New York laws of 1850 provide that railway companies "shall erect and maintain fences on the sides of their roads, with openings or gates or bars therein and farm crossings of the road, for the use of the proprietors," but the laws of 1854 omit the express requirement that there shall be farm crossings, though they provide that openings shall be placed at "farm crossings," and the laws of 1890, a compilation of existing laws on the same subject contain substantially the same provision. Under the circumstances, the court has decided that the provision for crossings was not repealed by such omission, and that railways are bound to maintain farm crossings. (Peckham v. Dutchess Co. Ry. Co. Supr. Ct. of N. Y., 20 N. Y., Sup., 30.)

Reserving Right to Cross Railway Along River.

Where the owner of land fronting on a river conveyed a strip across the same to a railway company, reserving the right to cross such strip at any place, and the deed provided that the railway company should lay its tracks so that the top of the rails should be on the level of the ground and that it should secure water pipes crossing the strip, such reservation created a permanent easement in favor of the unconveyed portion, not limited to the life of the original owner, but passed with a conveyance of the premises. The successor of the original grantee is bound by the stipulations of the original conveyance, and has no legal right to raise its track or roadbed across such land. (Chappell v. N. Y., N. H. & H. Ry. Co. Supr. Ct. of Errors of Conn., 24 At. Rep., 997.)

Assessment for Local Improvements not Unconstitutional.

The power to make assessments for local improvements in cities and towns is not an infringement upon the constitution rule requiring all taxes to be uniform. And assessments for local improvements upon the basis of frontage, where the lots abutting upon the improvement are of substantially equal depth, will be upheld where the same is not shown to be unfair. (City of Denver v. Knowles. Supr. Ct. of Colo., 30 Pac. Rep., 1041.)

Right to Water of Natural Streams in Colorado.

The water of every natural stream in Colorado is the property of the public. By a diversion and use for irrigation, a priority of right to the use of the waters of the natural streams may be acquired. This priority is a property right, and, as such, is subject to sale and transfer. There must be not only a diversion of the water from the natural stream, but an actual application of it to the soil, to constitute the appropriation for irrigation, recognized by the constitution. A diversion, unaccompanied by an application, gives no right. The awarding of priorities to ditches, in excess of the amount of water actually appropriated at the time, is error. A diversion and promise to use in the future will not support such a decree. (Ft. Morgan Land & Canal Co. v. South Platte Ditch Co. Supr. Ct. of Colo., 30 Pac. Rep., 1033.)

PERSONALS.

Mr. Silas Ludlam, engineer and surveyor, died in Brooklyn, N. Y., Nov. 3, at the age of 86.

Mr. W. Kiersted has removed from Kansas City, Mo., to Galveston, Tex., having been appointed by that city to prepare plans for new water supply and sewerage systems.

Mr. C. S. Mellen has been appointed Second Vice-President and Traffic Manager of the New York, New Haven & Hartford R. R., with headquarters at New Haven, Conn.

Mr. F. A. McClure has been appointed City Engineer of Worcester, Mass., vice Mr. Charles A. Allen, resigned. Mr. McClure has been Assistant City Engineer and Superintendent of Sewers, at Worcester.

Mr. Joseph W. Haskin died at Chicago, Ill., aged 68. He helped organize the company that built the first railway from Chicago to Milwaukee, and had been engaged in railway work and copper mining.

Mr. W. L. Stebbings, of Chicago, has been engaged by the Lincoln Park Commissioners of that city, as Consulting Engineer for the folding bridge they are to build, and he is also to prepare plans for a highway bridge over the lagoon.

Mr. L. S. Randolph has been appointed Electrical Engineer of the Baltimore Electric Refining Co., and has resigned his position as superintendent of tests in the motive power department of the Baltimore & Ohio R. R., as noted last week.

Mr. A. C. Merriam, General Superintendent of the Monterey & Mexican Gulf Ry., has been appointed General Manager of the Mexican National Ry., vice Mr. Theodore D. Kline, resigned. Mr. John Grace has been appointed to succeed Mr. Merriam.

Mr. David Mackenzie has been appointed Superintendent of the New London Northern Division of the Central Vermont R. R., with offices at New London, Conn., vice Mr. C. F. Spaulding, resigned. Mr. W. B. Hatch has been appointed General Purchasing Agent, vice Mr. Mackenzie, transferred.

Mr. James Gayley, Superintendent of the furnace department of the Edgar-Thomson Steel Works, has been appointed General Superintendent, vice Mr. Chas. M. Schwab, who has been appointed General Superintendent of the Homestead mills of the Carnegie Steel Co. Mr. D. Kerr, of the laboratory department, succeeds Mr. Gayley.

Mr. Augustus Mordecai, late General Roadmaster of the N. Y., P. & O. Division of the New York, Lake Erie & Western R. R., has been appointed Chief Engineer of the Erie system, with headquarters in New York, vice Mr. C. W. Buchholz, resigned to accept the position of President and Chief Engineer of the Quaker City Elevated R. R. Co., as noted in our issue of Oct. 6. Mr. Mordecai has been honorably connected with the N. Y., P. & O. R. R. for upward of 20 years, and brings to his new position a thorough familiarity with much of the system of which he now takes charge in the engineering department. He is a son of the late Major Mordecai, Ordnance Corps, U. S. A.

Lieut. Frederick Schwatka, U. S. A., the Arctic explorer, died at Portland, Ore., Nov. 2. He was born at Galena, Ill., in 1849, and graduated from West Point in 1871. He served in the 3d U. S. Cavalry from that year until 1884, when he resigned to enter civil life. From June, 1878, until September, 1880, he was in command of the Franklin search party in the "Arctic," which accomplished the longest sledge journey ever made, 3,251 miles in length, and occupying 11 months, 20 days. It experienced the coldest temperature ever recorded by white men traveling in the field, Jan. 3, 1880, a day on which the party moved camp 12 miles, showing 71° F. below zero. This was also the first expedition to travel through the whole of an Arctic winter. It buried a large number of Sir John Franklin's dead, and brought back the remains of one officer of that ill-fated expedition. Mr. Schwatka's second expedition was for the U. S. Government, in Alaska, along the Yukon River. Hiring about 80 Indian porters on the Pacific Coast, he had them carry his effects on their backs across the mountains to the head of the Yukon River, where the porters were discharged. Here his party built a raft and floated down the great stream on it for 1,305 miles, the longest recorded raft journey in the world. The upper 500 miles of the great stream was unknown until mapped by this expedition. Here they shot a number of rapids aggregating five to six miles in length, sailed and rowed across 136 miles of lakes in their cumbersome craft of 42 ft. in length and 16 in breadth, and altogether were nearly two months on this primitive vessel built of spruce logs. By this expedition the Yukon River got its first map, showing it to be 2,045 miles in length, navigable for 1,866 miles, and one of the most important rivers of the world. His third expedition was for the New York "Times," in Alaska, among the Mt. St. Elias mountains, in and around the base of the great mountain—the highest in North America—from which the snowy range takes its name. The Agassiz glacier, the largest in the temperate regions, was named and outlined by this party; this enormous mass of ice covering over 1,000 miles of territory. Mt. St. Elias was ascended for over 7,000 ft., the highest ascent ever made above the snow level, which here reaches to its base. His fourth expedition was in the northern part of Mexico, about two years ago. An account of this was printed at the time in the Indianapolis "News," in a series of letters which Lieut. Schwatka wrote. The explorer held medals from the Paris Geographical Society, the Imperial Geographical Society of Russia, and others; while he was honorary and corresponding member of the Bremen Geographical Society, the Swiss Geographical Society, etc.

NEW PUBLICATIONS.

MODERN LOCOMOTIVE CONSTRUCTION.—By J. G. A. Meyer, M. Am. Soc. M. E. New York: John Wiley & Sons. 4to, pp. 658; cuts 1,030; index. $10.

This book is intended to deal mainly with methods of every day practice, and is based upon a series of articles written by the author and published in the "American Machinist." Abstract theory is not gone into much, the aim being to make a handbook for those engaged in locomotive construction. The book is well made and well printed, and the illustrations are generally good, but the pages have margins of excessive width, and the whole get-up of the book is rather too elaborate for a work of this kind. A cheaper and more compact edition would certainly have a larger sale among men engaged in locomotive construction, and it is doubtful if many of the "intelligent mechanics" referred to in the preface will spend $10 on a single book. We have several times had occasion to comment unfavorably upon the tendency of American publishers of technical books to make such books unnecessarily large and elaborate and expensive in style.

The following list of chapters will give a fair idea of the treatment of the subject: 1, Introductory remarks, classification of locomotives, train resistance, tractive power, weight of engines, (20 pages); 2, Construction of cylinders, steam pipes, slide valves, (34 pages); 3, Valve gear, construction of links, (64 pages); 4, Pistons, crossheads, slides, stuffing boxes, (44 pages); 5, Frames and pedestals, axle boxes, (32 pages); 6, Driving axles, driving wheels, counterbalance, (53 pages); 7, Main rods, side rods, crank pins, (76 pages); 8, Throttle pipes, throttle valve gear, safety valves, whistles, pumps, check valves, (57 pages); 9, Spring gear and springs, (17 pages); 10, Boilers, grate surface, heating surface, riveted joints, extension fronts, (74 pages); 11, Ashpans, smokestacks, exhaust pipes, (19 pages); 12, Sand boxes, bells, pilots, engine braces, (25 pages); 13, Engine trucks, (17 pages); 14, Oil cups, valves, cocks, injectors, (11 pages); 15, Tenders, tender trucks, (32 pages); 16, Useful rules, formulas and data, (22 pages); 17, Compound locomotives, (16 pages). The drawings are in detail, showing the dimensions and arrangements of parts, and they are all on the pages, there being no folding plates, which is a distinct advantage. Tables of dimensions of parts for engines of different sizes are scattered through the chapters, but an important omission has been made in not giving complete lists of dimensions and particulars of standard engines of different types, so as to present a summary of the information and dimensions given in various places, as well as to add further facts not given. The only engines of which such particulars are given are a standard eight-wheel passenger engine and standard six-wheel switch engine of the Pennsylvania R. R.

The index is quite extensive, but not very well arranged, and we find in it no reference to suburban tank engines, or to the mastodon or twelve-wheel engine for heavy freight service, and these engines do not appear

to be included in the book. Some things, however, which are mentioned are not indexed. We also notice some omissions in the text, such as the neglect to say how boilers are lagged, or to describe any form of metallic packing. The compound locomotives described are the two-cylinder engines of the Schenectady Locomotive Works, and Rhode Island Locomotive Works, and the four-cylinder engines of the Baldwin Locomotive Works. On the whole, the book is a very complete and practical work on the details of construction of modern American locomotives, and is a valuable addition to the literature of mechanical engineering. We know of no handier work to have at hand when it is desired to look up the main facts of practice about any part of the locomotive.

THE THEORY OF ERRORS AND METHOD OF LEAST SQUARES.—By William Woolsey Johnson, Professor of Mathematics at the United States Naval Academy. New York: John Wiley & Sons; 12mo, cloth, pp. 152; two tables. $1.50.

This is a very complete and well written little treatise on the method of least squares. It is better suited, however, for the advanced student in mathematics than for the engineer, who as a rule cares to study the subject only enough to be able to make practical use of it. The last 22 pages of the book are devoted to a table of values of the probability integral and a table of squares, cubes and square and cube roots of numbers up to 1,000. The typography throughout deserves great praise, and the absence of the broad margins and marble dusted paper so frequent in technical books nowadays, makes one feel that the money which he pays for the volume is not spent chiefly for blank paper.

AN INTRODUCTION TO GEODETIC SURVEYING.—By Mansfield Merriman, Ph. D., Professor of Civil Engineering in Lehigh University. New York: John Wiley & Sons. 8vo, cloth; pp. 170; 19 cuts. $2.00.

The first part of this book is devoted to a discussion of the figure of the earth, considering it successively as a sphere, a spheroid, an ellipsoid, an ovaloid, and a geoid. This portion of the book was published separately ten years ago. In the second part is given a concise explanation of the method of least squares, sufficiently full to enable an engineer to make intelligent use of the method. The last and most interesting part of the book describes the field work and computation of triangulation, in geodetic surveys. While brief, it gives the practical points most necessary to a beginner in this fascinating department of engineering work.

FIRST REPORT OF THE BUREAU OF MINES, (Ontario, Canada), 1891. By Archibald Blue, Director, Toronto, 1892; Warwick & Sons. 8vo; pp. 253; folding map.

About 30 pages of this report are taken up with geology proper, and these deal chiefly with the part of Ontario lying north of Lakes Huron and Nipissing. The map forms a valuable supplement to this section of the report. There is a report on the different mines of the province from the Inspector of Mines, and a long chapter on the operation of the Mining Act. Metals, structural materials, natural gas, heat, and artesian wells are treated with considerable detail.

COMPARATIVE ARCHITECTURE. By Barr Ferree, New York, 1892. 8vo, pamphlet; pp, 16.

This is a tastefully made reprint of a paper read before the American Institute of Architects. It is a plea for a change in the method of studying architecture —for the adoption of a comparative method rather than the historic or descriptive methods. The author thinks that the want of popular interest in architecture is largely due to lack of scientific treatment, and that with such treatment the science would soon rank in importance in the popular mind with psychology or political economy or general history.

ASSOCIATION OF PROVINCIAL LAND SURVEYORS OF ONTARIO. Proceedings of the seventh annual meeting, held at Toronto, Feb. 23, 24 and 25, 1892; 8vo.; pp. 166.

This volume contains the proceedings, President's address, reports of officers and of committees on Land Surveying, Drainage, etc. There are also the following papers: "Exploratory Surveys," William Ogilvie; "Are the Great Lakes Retaining their Ancient Level," J. G. Barton, R. N.; "Cements and Cement Mortars," M. J. Butler; "Does the Passing of an Act of Parliament Always Do Justice?" A. Niven; "Hints to Surveyors About to Survey a Township for the Ontario Government," W. R. Burke; "Compass Lines," John McAree; "Old Records in Relation to Municipal Surveys," George B. Kirkpatrick; "Sewerage for Towns and Villages," Herbert J. Bowman; "Georgetown Water-Works," James Warren; "The Hamilton & Barton Incline Railway," J. W. Tyrrell; "Exploring for Nickel" Charles E. Tilton; "Railway Surveys," Henry K. Wicksteed; "Rock Excavation of Trenches for Water-Works Purposes," A. L. McCulloch. The Secretary of the Association is Mr. A. J. Van Nostrand, Toronto, Ont.

TRADE PUBLICATIONS.

SPIRAL RIVETED WATER PIPE. Abendroth & Root Mfg. Co., New York City. Pamph., 8vo, pp. 39, with cuts.

This catalogue is illustrated with some excellent engravings showing various places where riveted pipe is in use.

METAL SAWING MACHINES.—Q & C Co., Chicago. 8vo, pp. 24; illustrated.

The Bryant metal sawing machine was described and illustrated in our issue of April 21, and this pamphlet gives illustrations and particulars of different sizes and styles of the machine for various uses, including portable machines for track work, etc., and power machines for heavy work.

SMOKE PREVENTER.—Sargent & Greenleaf, Rochester, N. Y.; 8vo, pp. 31; illustrated.

The Sargent patent automatic smoke preventer uses a steam jet and air current, which are gradually and automatically shut off as the fuel becomes incandescent, the maximum admission being just after the fresh fuel has been thrown into the furnace. The general subject of smoke prevention is discussed, and several reports of tests are given, including one by Mr. Geo. W. Rafter, M. Am. Soc. C. E. In another column we give some particulars of the Sargent apparatus.

INDICATORS, PLANIMETERS, PANTAGRAPHS SPEED COUNTERS.—Thomson Hydraulic Co. New York. 16 mo., pamph., pp. 16.

This little circular describes certain additional products of the kind noted, dealt in by this new company, as an adjunct to its main business of dealing in the new "Neptune" water meter invented by Mr. John Thomson. The indicator is the Calkins, beyond doubt a very fine instrument, and the great claim is made for it that it "will indicate with great accuracy up to 600 revs. per minute. But we cannot help doubting whether any indicator ever made will do that. The inertia of the parts at such great speed, however lightly made, must seriously modify results, it would seem, though it should be possible to test this by rapid alternations of known pressure.

SOCIETY PROCEEDINGS.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—The ordinary meeting will be held at the Society's rooms, 112 Mansfield St., Montreal, Nov. 11. At this meeting the discussion on "Transition Curves," by Mr. H. R. Lordly, will be resumed, and a paper on "The Simplification of the Quadruplex," will be read by Mr. D. H. Keeley, A. M., Can., Soc. C. E. C. H. McLeod, Secy.

ASSOCIATION OF ENGINEERS OF VIRGINIA.—The association held its regular autumn meeting in Roanoke, Va., Oct. 21 and 22, Mr. Coleman, President, in the chair, and a large number of members in attendance. A report of the Committee on "Common Roads of Virginia," was read, and discussed. Several other interesting papers, among them one on "Locomotive Tests," by Mr. G. R. Henderson, were read and discussed. The association will hereafter meet monthly.

J. R. Schick, Secy.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—The next meeting will be held at the Kimball House, Atlanta, Ga., on Thursday, Nov. 17, at 10 a. m. Officers will be elected for the year 1893.

The subjects for discussion will be as follows: "The Best Course to Pursue to Reduce Oil Consumption in Engines and Cars"; "Driving Boxes, Best Material and Shape, in Order to Prevent Breakage and Wear; Is the Solid Box Suitable for Heavy Engines?"; "Stay-Bolt Inspection." The following committee is expected to make a report: W. H. Thomas and Pulaski Leeds, on "Repair Work on Large Systems and Location of Plants for Same."

S. A. Charpiot, Secy.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—The regular monthly meeting was held Oct. 18; Mr. Alfred E. Hunt in the chair; Mr. R. N. Clark, Secretary; 70 members were present.

Mr. George H. Hutchinson, of the Keystone Bridge Co., read a paper on "Mill Building Construction with Details from Practice," which is printed in full on another page.

At the meeting of the Chemical Section of the Society, Prof. Francis C. Phillips, Professor of Chemistry of the Western University of Pennsylvania, was elected Chairman in place of Prof. John W. Langley, resigned. Mr. Joseph Eastwick read a paper on "Nickel Ores," referring to the character and distribution of various ores now used for the production of nickel. This paper was discussed by Mr. Chas. Mixer, chemist of the Emmens Metal Co., of Youngwood, Pa., who gave many facts concerning nickel ores, and their metallurgy. The discussion extended to nickel alloys, and to methods of analysis of nickel ores and their compounds. Mr. Jas. O. Handy read a communication covering experience with Hudeshagin's method for sulphur determination in coal. He found it no improvement over Eschka's process, results by both methods agreeing.

The Smoke Committee will report finally at the regular meeting, Nov. 15, and it is expected that Prof. F. C. Phillips and Mr. R. N. Clark will read a joint paper on "Water Purification, and Analysis of Local Waters" before the Chemical Section, Nov. 22.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting on Nov. 2, Mr. Cohen, President, in the chair, a committee was appointed to prepare a memoir of the late Mr. James Francis, Past President. The committee is composed of Gen. Geo. S. Greene, Col. J. W. Adams, and Mr. W. E. Worthen, all associates of Mr. Francis.

The Secretary then read an abstract of Mr. W. L. Saunders' paper on "Electric Rock Blasting: The American Method," which was noted last week. Mr. S. Whinery said that in getting out rip-rap from a large quarry of solid limestone for a government dam, the actual cost of the work was 28.4 cts. per cu. yd., including tools, superintendence, etc. The stone was moved 60 ft. and loaded on flat boats. The quantity was measured by cross-sectioning the quarry each month and calculating the amount removed. He thought Mr. Saunders underestimated the value of blast testing machines, such instruments being very important. He had used an instrument consisting of a small compass with a coil of wire and a one-cell Leclanche battery. Every fuse should be tested before it is put in the blast hole. The insulation of leading wires is not so necessary as generally supposed, and bare wire less than 100 ft. long may be used in water. For tamping he had experimented with plaster of Paris, allowed to set half an hour. The results were satisfactory, but its general use is impracticable. Foremen generally put in too heavy a charge, and he had reduced the quantity of explosives 50% by the use of a graduated stick, showing the number of inches of charge to be used. Mr. Parker said he had used bare leading wires in salt water.

The Secretary announced that papers are now being published as soon as possible after they have been read, the discussions being published later, and the date up to which discussions will be received being given in a foot note to the paper. There is a shortage in the supply of papers, and the fund for the collations has not yet reached the desired amount.

The following candidates were declared elected members: W. W. Carson, Prof. of Civil Engineering, Univ. of Tennessee, Knoxville, Tenn.; Horace Harding, U. S. Asst. Engr., Tuskaloosa, Ala.; B. S. Wathen, Res. Engr., Texas & Pacific Ry., Dallas, Tex. Associate Member: John H. Kinealy, Prof. of Mech. Engineering, Washington Univ., St. Louis, Mo.

COMING TECHNICAL MEETINGS.

WISCONSIN POLYTECHNIC SOCIETY,
Nov. 14 Secy., M. F. Schinke, City Hall.
ENGINEERS' CLUB OF KANSAS CITY,
Nov. 14. Secy., Waterman Stone, Rated Building.
AMERICAN SOCIETY OF MECHANICAL ENGINEERS,
Nov. 14 to 18. Annual meeting. Secy., F. R. Hutton, 12 West 31st St., New York.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA,
Nov. 15, "Smoke," Nov. 22, "Water Purification. Secy., R. H. Clark, Pittsburg, Pa.
ROADMASTERS' ASSOCIATION OF AMERICA,
Nov. 15, 16, 17. Chattanooga, Tenn., and Atlanta, Ga. Secy., J. H. K. Burgwin, Grand Rapids, Mich.
BOSTON SOCIETY OF CIVIL ENGINEERS,
Nov. 16. "Notes on English Railways." Secy., S. E. Tinkham, 36 Broomfield St.
AMERICAN SOCIETY OF CIVIL ENGINEERS,
Nov. 16. Secy., F. Collingwood, 127 East 23d St., New York.
ENGINEERS' CLUB OF ST. LOUIS,
Nov. 16. Secy., Arthur Thacher, Odd Fellows' Building.
ENGINEERS' CLUB OF CINCINNATI,
Nov. 17. Secy., J. F. Wilson, 24 W. 4th St.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB
Nov. 17. Kimball House, Atlanta, Ga. Secy., F. A. Charpiot, Macon.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO,
Nov. 17. Secy., C. F. Franson, Portland Block.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS,
Nov. 18. 201 Washington Building.
ENGINEERS' CLUB OF PHILADELPHIA,
Nov. 19. 1122 Girard St. Secy., L. F. Rondinella.
SWEDISH ENGINEERS' CLUB,
Nov. 19. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago; Secy., John Erlson.
CENTRAL RAILWAY CLUB,
Nov. 23. Secy., S. W. Spear, E. Buffalo, N. Y., Iron Works.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS,
Dec. 2. Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST,
Dec. 2. Secy., O. Von Geldern, 719 Market St., San Francisco.
NORTHWEST RAILROAD CLUB,
Dec. 8. Union Station, St. Paul.
MONTANA SOCIETY OF CIVIL ENGINEERS,
Dec. 3. Secy., F. D. Jones, Helena.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL,
Dec. 5. Secy., C. L. Annan, City Engineer's Office.
NORTHWESTERN SOCIETY OF ENGINEERS,
Dec. 6 Secy., D. W. McMorris, Burke Block, Seattle, Wash.
CIVIL ENGINEERS' CLUB OF CLEVELAND,
Dec. 6. Secy., Chas. S. Howe, Case School
DENVER SOCIETY OF ENGINEERS AND ARCHITECTS,
Dec. 6. Secy., Geo. H. Angell, 36 Jacobson Block.
ATLANTA SOCIETY OF CIVIL ENGINEERS,
Dec. 6. Secy., Parker N. Black, Capitol Block.
ENGINEERS' SOCIETY OF PHŒNIXVILLE,
Dec. 6. Secy., W. Halliburton.
WESTERN SOCIETY OF ENGINEERS,
Dec. 7. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
ENGINEERS' CLUB OF MINNEAPOLIS,
Dec. 8. Secy., F. W. Cappelen, 1628 Hennepin Ave.
CANADIAN SOCIETY OF CIVIL ENGINEERS,
Dec. 9. Secy., C. H. McLeod, Montreal, P. Q.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE,
Dec. 8. Secy., Edward Mead, Norton Building.
WESTERN RAILWAY CLUB,
Dec. 8. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERING ASSOCIATION OF THE SOUTH,
Dec. 8, Secy., O. H. Landreth, Nashville, Tenn.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION,
Dec. 9. Secy., D. W. Meeker, St. Paul.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS,
Dec. 14. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB,
Dec. 14. "High Speed for Trains." Secy., F. M. Curtis, O. C. R. R., Boston.
NEW YORK RAILROAD CLUB,
Dec. 15. Secy., H. G. Prout, 73 Broadway, N. Y.

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AND
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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

SUBSCRIPTION RATES: One year, $5.00; 6 months, $2.50; 4 months, $2.00; single copies 15 cents. To all foreign countries in the Postal Union, add $2.08 to above prices for postage. Subscribers can have the mailing address of their paper changed as often as they desire. They should send both the old and the new addresses. No club rates are allowed.

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The Iron and Steel Institute paper in another column on the breakage of chilled rolls is especially interesting to American engineers at the present time in view of the fact that such failures, according to the author, have been most frequent in rolls working on black sheets for tin plate. In rolling sheets of thin gage it is not feasible to keep the rolls cool by water jets, as the plate would be cooled too rapidly. The necks of the rolls must, however, be kept cool in order to prevent the lubricant from charring and the bearings from cutting. The author considers the frequent breakage of the necks to be due to the unequal expansion of the metal, and recommends a gradual reduction in diameter of the roll at the end to prevent the strain from unequal expansion being concentrated at the junction of the neck and the roll. He does not favor increasing the diameter of the necks, except where absolutely necessary, holding that the increased conduction of heat from the roll to the neck and the increased friction are apt to offset any advantage obtained.

The notes concerning current accidents which we publish on the first page of every issue have frequently to be made up from very meager and unsatisfactory reports, contained in the first press dispatches from the scene of the disaster. While we endeavor so far as possible to sift out errors in making our own notes of such accidents, it is exceedingly difficult to get at the exact truth from two or more accounts, differing in many details and (in most cases) all more or less incorrect. When errors of technical importance do creep into our accident records we take pains to publish such corrections as the case demands. In describing last week the collision on the Northeastern Ry. in England, we relied on the first press reports, which stated the fire that followed the collision to have been caused by escaping gas. A later report in reply to a cablegram inquiring the cause of the fire states that it was due to coals which escaped from the engine firebox, as do some of the later press dispatches.

We also referred last week to the Clapham, England, collision, on Aug. 20, in which three cars were burned, the fire being also reported to have been set by escaping gas. This report we also learn to be contradicted by good authority. The smashup was a bad one and the roof of one of the cars slid completely over the locomotive. The evidence is strong that this fire also was set from the locomotive firebox; and it is at least worth while suspending judgment upon it until the results of the official investigation by the Board of Trade are made public. It is very natural that, if any bystander saw anywhere in the wreck a flash of flame from escaping gas, he should ascribe the cause of the fire to that, though it really might have nothing to do with the cause and very little with the effect of the fire.

Probably few engineers, even among those engaged in machine designing, realize the important gains which may be made at the present time by the use of ball bearings in certain classes of machinery. In a general way it has long been known that a great decrease in friction results from the use of ball bearings, but the cost of such bearings has made their use quite uncommon until a very recent date. At present, however, the use of ball bearings in bicycles has not only familiarized every one with their advantages, but has created such a demand for balls that they are now made by machinery in enormous quantities, of remarkable perfection and finish, and at a cost which makes their use feasible for a much wider range of work than was the case a few years ago. As often happens in mechanical progress, an increase in demand has ultimately effected a great reduction in the price.

At present balls of polished tool steel, hardened or tempered, cost net in bicycle sizes (¾ in to 5-16 in.) $0.70 to $1.05 per 100. Larger sizes, for which the demand is less and orders are generally smaller, cost from $1.90 for ⅜-in. to $9.50 for 1 in. per 100. Balls rough ground, not polished, but varying not over 1-100 in. in their diameter, cost 20% less than the above prices.

Remembering that the brass bearings which ball bearings replace are generally expensive, both in material and manufacture, it will be seen that the above prices of balls are so low as to permit them to replace brass bearings in very many cases.

Of course the principal use of ball bearings at present is to economize power. On the bicycle, for instance, the less the power wasted in friction, the higher the speed or the greater the distance which will result from a given exertion. Where power is obtained from a steam engine or a water wheel its cost is so small that the mere saving in power by the use of ball bearings could be of little importance; but where human or animal muscle furnishes power, it will pay to go to considerable expense to economize it wherever such economy will increase the results obtained from a given amount of labor. For example, we illustrated recently (Oct. 6) a ball bearing used on a ratchet drill to transmit the feed pressure to the tool, which is claimed, not unreasonably, to make possible a great increase in the speed of drilling. There is a variety of tools and machines driven by hand power to which ball bearings might be applied with much profit.

It requires a very small gain in the efficiency of a tool or machine in the shape of increased product to pay the interest on a considerable increase in its first cost.

Another thing in favor of the use of ball bearings is that they are less affected by dust and grit or by lack of oil than bearings which involve sliding friction. The gain from this one cause alone may often well repay the extra cost of the ball bearing.

For use in power-driven machinery the ball bearing is of greatest utility in places where an ordinary bearing gives trouble from heating and cutting. Heavily loaded thrust bearings, especially on worm gears, and overloaded shaft bearings which cannot be increased in length, will have their friction so reduced by the substitution of a properly designed ball bearing as to stop all trouble from heating. For example, a well known maker of machine tools in Massachusetts recently built a double-end car axle lathe driven by a worm gearing. The thrust of the worm was received on a hardened steel ring, but the latter proved a total failure on account of the friction at this point. A chip only ¼ in. deep at one end only of the lathe could not be cut. A ball bearing with 95 balls, ⅜-in. size, was then fitted to the thrust bearing and the lathe did its work perfectly. The railway company now using it states that a 1-in. chip with 1-16 in. feed can be taken at both ends of the lathe at once.

For high speed shafts, the advantage of the ball bearing over the plain bearing are by no means so great as for heavily loaded bearings, the friction of the two approaching each other. It would doubtless conduce greatly to the use of ball bearings if more information were available as to the laws governing their design. The subject is one which offers a wide and profitable field for experimental work. There is little or nothing as yet in technical literature upon the subject, and there are very few whose experience has been such as to enable them to give definite information upon it.

THE ETHICS OF CONSULTING PRACTICE.

A "Code of Ethics," or of professional good manners and fair dealing, is necessarily a matter of slow growth. It cannot exist except by general acceptance. General acceptance can rarely be obtained for any rule of conduct which has not become more or less traditional, so that it is known as a fact to be all but universally accepted. Even if accepted in the abstract the selfishness of man will lead many to yield to any temptation to break it, unless they know that there exists such an overwhelming sentiment in its favor that it will cast a cloud on their professional standing to do so, and such general knowledge of it as to make it absurd to claim that they erred in ignorance.

All this requires time. All the older professions have pretty rigid codes of ethics, within certain lines at least, which a man can infringe on only with great peril to his own standing. It is an historical fact that these have been of slow formation. Engineering is a new profession, therefore it cannot be said to have any such rigidly established rules of practice. They are not laws which can be passed any day. They are simply conventions, which are regarded by the majority as so obviously proper that only a black sheep would violate them, and so well known that no excuse of ignorance is tenable.

But while engineering may not have any very rigid code of ethics for a generation to come at least, yet after all, there are certain great principles of equity and courtesy which hold in all professions and which no man should be or is permitted to violate, code or no code. Such features of these codes as are common to all of them may fairly be said to be already established in engineering, though some may err by ignorance or malice. The only aim of such a code is to establish equity and courtesy between different members of the same profession, and whoever distinctly violates equity and courtesy in his treatment of a fellow-engineer, violates—if not an already established code, as we believe he does—at least what will be the code when there is one, and what every engineer should seek to establish. We regret to be compelled to believe that many engineers (who probably do not fully realize the fact in most cases), are not unfrequently offending grossly against both equity and courtesy in their professional customs, for lack of that check which fallible man so often needs, an established convention to tell him what he ought to do, and compel him to do it, saving him from doing his own thinking and appealing only to his own sense of right. We may go further, and say that facts which come to our knowledge compel us to believe that some few engineers on some occasions at least, are presuming on this absence of a rigid code to violate with expected impunity the most elementary requirements of courtesy and fair dealing in pursuit of their own selfish ends. This ought not to be so, but it is. Alas, how weak the sense of right is, in how many men, when their apparent momentary interests conflict with it!

For this reason certain elementary rules of professional good manners, at least, ought to be established in engineering practice as soon as possible, even if they be not, as we hold they are, already established. To such elementary rules only we propose to confine our attention, with more particular reference to the practice of consulting engineers. We need not say that this practice has enlarged greatly in recent years, and is likely to enlarge still further. There are probably far more than twenty times as many consulting engineers in our large cities as there were twenty years ago. It is a sign of promise for the profession that it should be so. Too large a percentage of its members are mere salaried employees. It will never have the standing which it ought until the proportion is much less.

But it is obvious that to have this so the con-

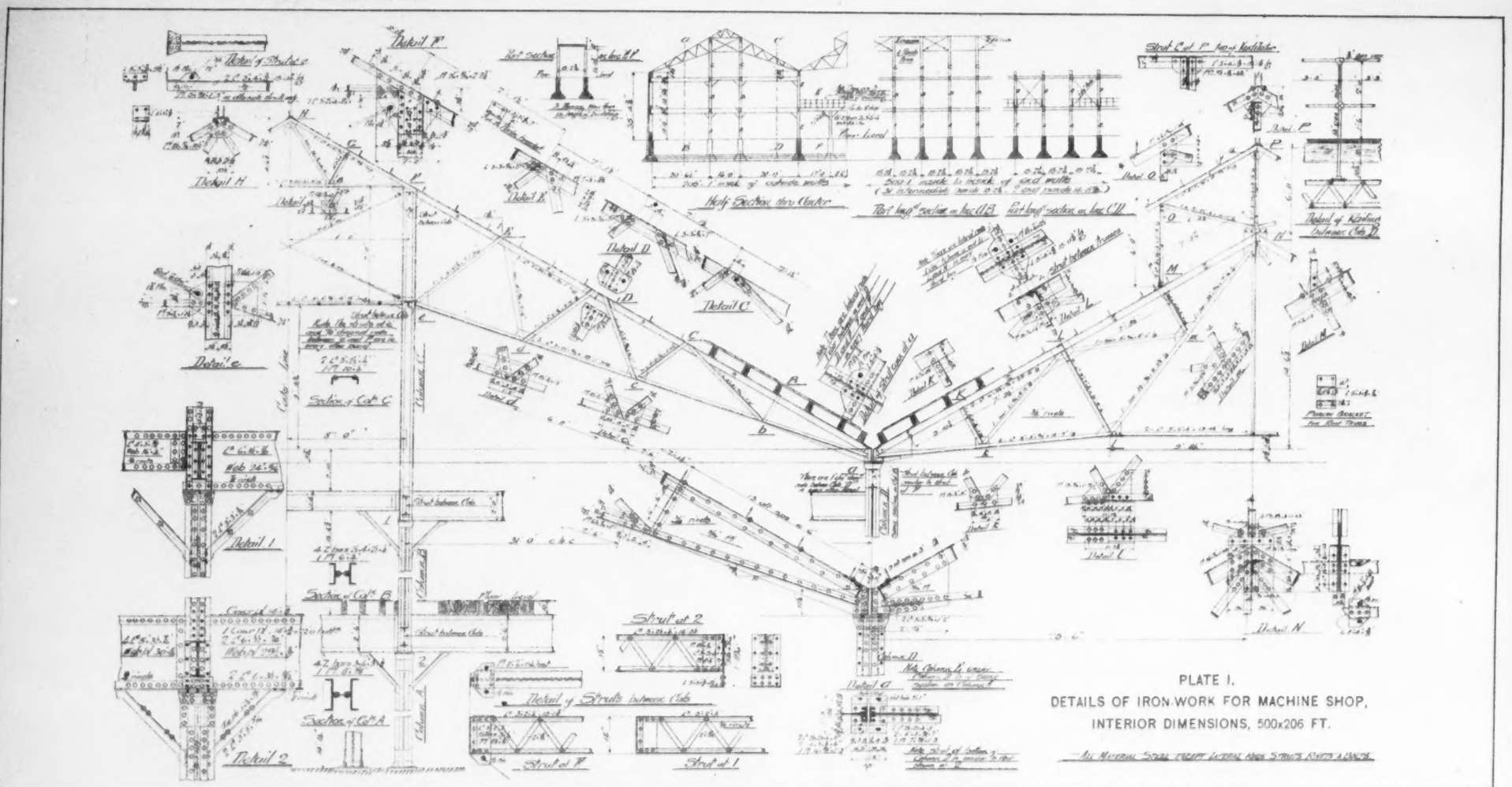


PLATE I.

DETAILS OF IRON-WORK FOR MACHINE SHOP,

INTERIOR DIMENSIONS, 500×206 FT.

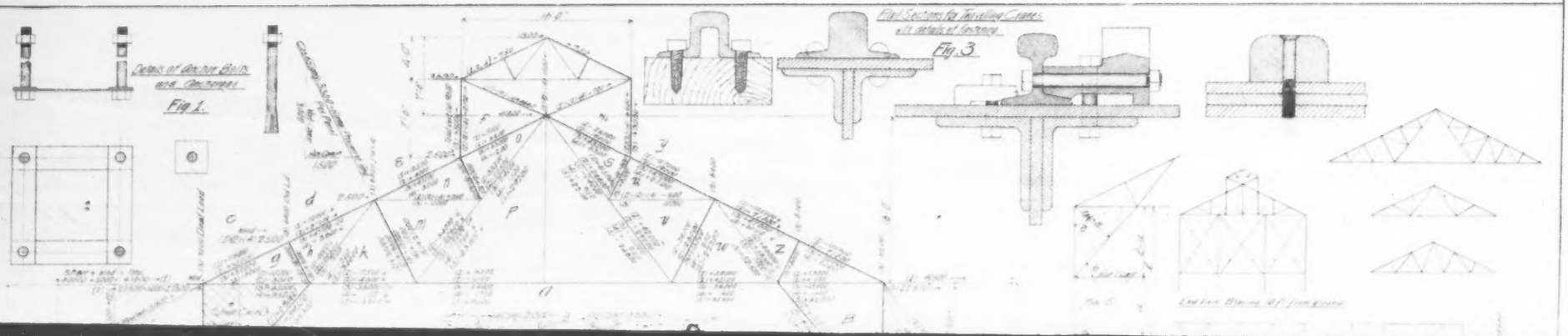
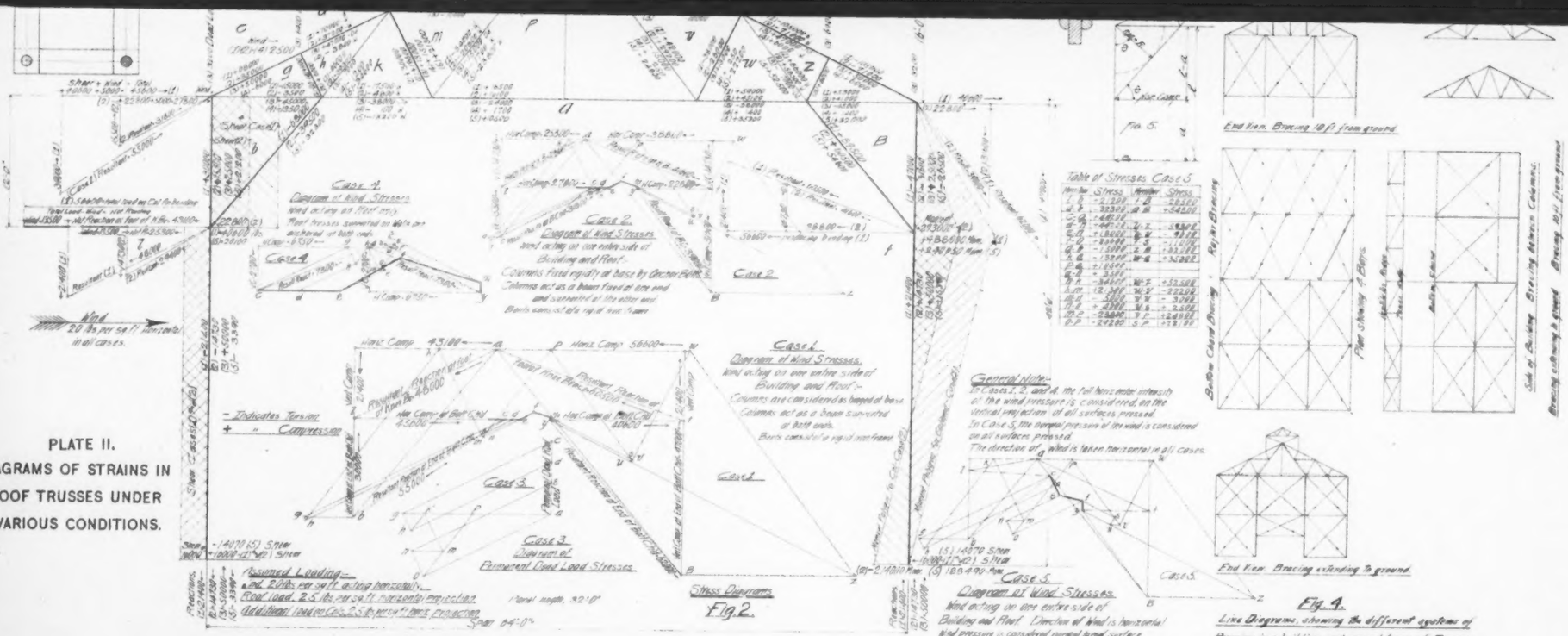
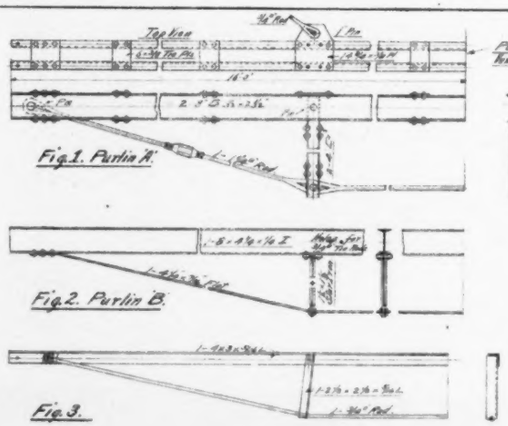


PLATE II.
DIAGRAMS OF STRAINS IN ROOF TRUSSES UNDER VARIOUS CONDITIONS.


Case 1
Diagram of Wind Stresses.
Wind acting on one entire side of Building and Roof.
Columns are considered as hinged at base.
Case 2
Diagram of Wind Stresses.
Wind acting on one entire side of Building and Roof.
Columns fixed rigidly at base by Anchor Bolts.
Case 3
Diagram of Permanent Dead Load Stresses.
Case 4
Diagram of Wind Stresses.
Wind acting on roof only.
Case 5
Diagram of Wind Stresses.
Wind acting on one entire side of Building and Roof.
Stress Diagrams
Fig. 2.
Table of Stresses Case 5.
General Note:
Fig. 4.
Line Diagrams, showing the different systems of Bracing in a building and several types of Trusses.



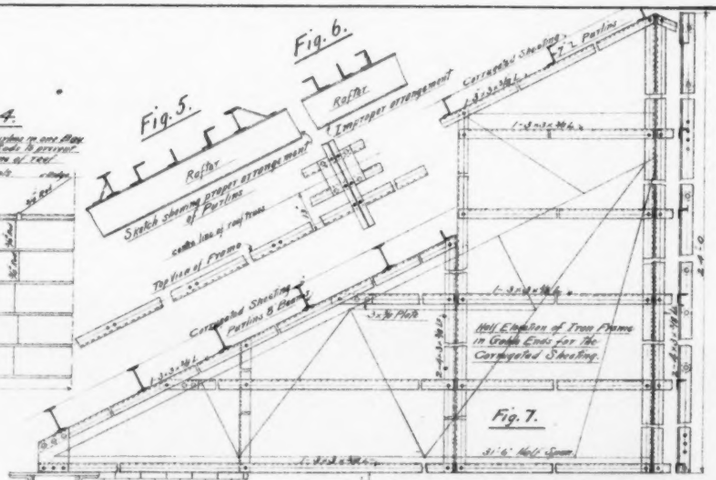
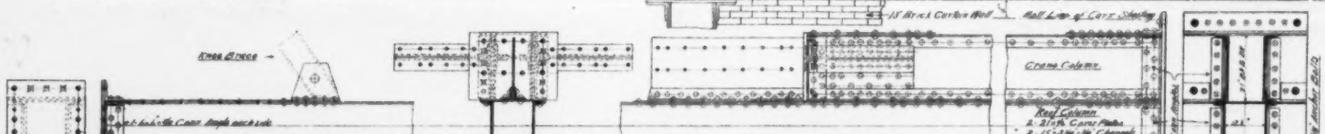


PLATE III. VARIOUS STYLES OF TRUSSED PURLINS.



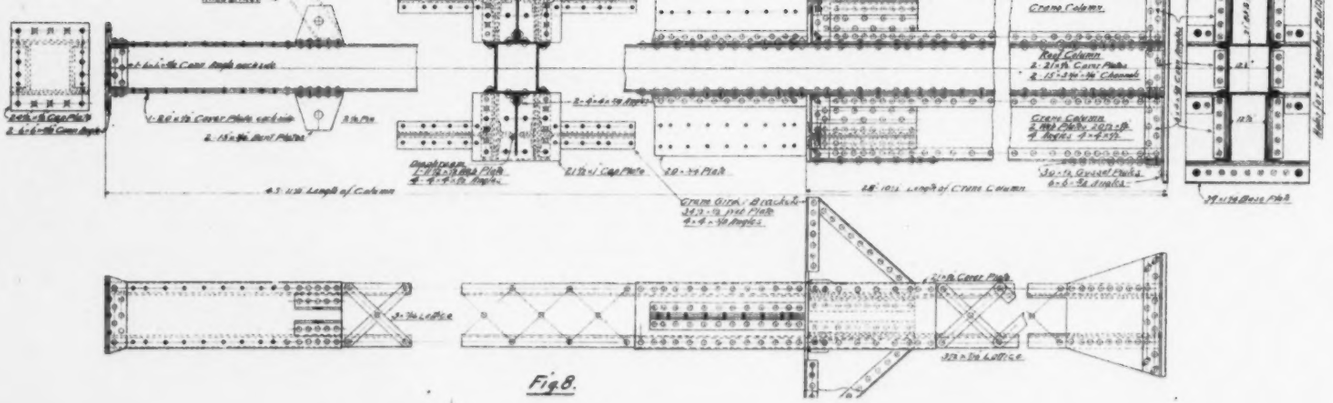


Fig.8.

DETAILS OF THE CONSTRUCTION OF MILL BUILDINGS.

Accompanying paper by Geo. Hunt Hutchinson, Assoc. M. Am. Soc. C. E., before Engineer's Society of Western Pennsylvania.

CHAS. HART & SONS, LITH. 30 VESEY ST., N. Y.

sulting engineer must not offend against his brethren unfairly, for his own interest alone. To a large extent his practice and his livelihood depend upon them. That some of them do thus offend, and most unfairly (if in some cases thoughtlessly) we know to be a fact. We shall try to indicate wherein.

In every professional act the consulting engineer owes a duty to three persons: 1. To himself and to his own reputation; we put this first because it is very apt to be first in fact, and if rightly interpreted, may fairly enough be so. 2. To his client or employer, to give him the full benefit of all the knowledge and judgment he has. 3. To his fellow-engineers, and especially to any engineer directly affected by his acts, that he do not discredit or injure them unnecessarily or unfairly. It stands to reason that every rightful professional act must meet all three of these conditions, because neither one of them means more than that the consulting engineer is to tell the truth, the whole truth and nothing but the truth, according to his best judgment, and in such a manner as to injure no one in reputation or estate except as the truth may injure him.

From this simple principle, if generally accepted, would necessarily result certain rules of practice (strictly analogous to those which obtain in the older professions) which are now frequently violated in form by most of not all of the consulting engineers in practice, though we fully believe violations of the spirit are very rare and when committed as damnatory as if engineering had a code of ethics centuries old. Some of these we should define as follows:

1. It should be considered unprofessional and dishonorable for any engineer to accept a call in consultation for any work which is already in charge of an engineer, EXCEPT THE CALL COME FROM OR THROUGH SUCH ENGINEER IN CHARGE. Engagements tendered from principals should be considered or accepted ONLY when there is no engineer already in charge of the work.

We should lay this rule down with all possible generality and emphasis. We consider that it admits of no exceptions whatsoever. We hope, and believe, that the day will come when it will be considered a shameful act that any engineer should violate even the letter of this law, as we believe it is already established as a shameful act to violate its spirit. Justice, courtesy and expediency alike demand that the letter as well as the spirit of the rule should be must rigidly respected.

First, as to justice: The very act of calling in another engineer in consultation necessarily implies a doubt whether the engineer in charge has done or will do the best possible on his own unaided judgment. How can the consulting engineer make sure of this unless he knows at first hands what the engineer's plans and motives were and are, and how can he know this unless the engineer in charge either resigns or formally requests his engagement, and thereby binds himself to tell all he knows in his own behalf? But unless he does so the consulting engineer cannot be sure of doing justice either to himself or to his employer or to his fellow-engineer, and certainly not to all three. It by no means follows that the engineer in charge need be really desirous of his engagement; he may well be in fact most unwilling, and if so his employer has a perfect right to put pressure upon him and say: "Either consent or resign." But the pressure should come from the employer, not from his fellow-engineer. And neither has a right to act behind his back or on the sly, without giving him time for preparation, unless he is accused or suspected of criminal acts. Supposing he knows himself to be in the wrong, and prefers to step down and out, and have no more said about his share of the work, has he not a perfect right to do so, and is it decent or fair for his fellow-engineer to impede his doing so? Many an engineer has fallen into terrible blunders, learned a lesson from them, and thereafter had an honorable and successful career. Is it fair or honorable to impede any man from doing so, by driving him into a corner before he has a chance to escape?

Then as to courtesy: Why should any man needlessly wound another's feelings or be rude to him? Grant (what is not true) that it is only a form to require the call to come through and from the engineer, and not from his principals; it is a courteous form; it at least does no harm, for it is not to be supposed that the honorable engineer will make any difference in his report, whether he is called by the one or the other. "Nothing extenuate and naught set down in malice" will be his inflexible rule in any case. The engineer who knows himself in the right will welcome the appointment of a consulting engineer if his mode of appointment does not in itself imply distrust of him. If he knows or fears he is in the wrong, why add the perfectly needless affront of ignoring his existence to one who is already suffering the pangs of anxiety or mortification?

Then as to expediency: If engineers do not respect each other, who shall respect them? Even if a man be indifferent to both justice and courtesy so he can gain his ends,—and there are, alas, too many such in all callings—does he not lose much and gain nothing by setting the example of treating the position of engineer in charge with no respect? He may be in that position himself next year; will it then be pleasant to him to be thus ignored, and possibly have his reputation taken away behind his back by a charlatan whose real standing he could have made known to his principals before his engagement, had he had the chance? Will he not then more clearly see the expediency and justice of giving him at least a chance to be heard as to who shall be called in before the call is given?

It is not as if the engineer would risk giving offense or losing an engagement by being thus "finicky," if any one still looks on it as finicky. He would never do so. He need only reply to any such irregular call something like this: "I shall be pleased act in the matter with the consent of your chief engineer, but it is a custom of the profession that all such calls should come through the engineer in charge, if there is one, to which I always like to adhere, as it seems fairer and more courteous to him." The whole profession of engineering would be more respected for such an act, as well as the writer and the other engineer concerned.

Yet we do not at this writing know positively of a single engineer who habitually lives up to this simple and harmless rule, as one to be "everywhere, always and by all" respected. We do know positively of a dozen or more who frequently disregard the letter of the rule; most of whom we fully believe neglect only the form and not the substance of courtesy and right; we also have strong reason to believe that there are some engineers who only need small temptation to disregard both the letter and the spirit.

But if the first rule suggested be reasonable and proper, ten times more is the following, which we earnestly hope will soon be so firmly established, if it is not now in its substance, that it will mean professional ruin and disgrace for any engineer to violate it knowingly even once, in a case where another engineer's reputation or standing is liable to be injuriously effected, for to do so implies a moral obliquity which should exclude a man from an honorable profession. And yet, the letter of this rule at least is very frequently violated, and in some cases at least its spirit also, though we hope rarely:

2. It should be considered unprofessional and dishonorable for any engineer to report upon any work which is already in charge of an engineer EXCEPT TO SUCH ENGINEER IN CHARGE. Reports to principals direct should only be made when there is no engineer in charge; nor then, when there has been an engineer in charge whose professional acts are impeached in such report, without prior tender of a copy of such parts of the report as may personally concern him, for his perusal and response.

It is difficult to speak with charity or patience of violations of the spirit of this rule, for every man with any sense of honor in him will feel instinctively that it is a base and cowardly act, of the very essence of dishonor. We are glad to believe that the letter only of the rule is frequently violated; the spirit is conformed to when prior information of the nature of the report, with opportunity to disprove any charges or have his own view fairly stated, is given to any present or former engineer in charge. But both the letter and spirit are violated in many instances, and by men who stand high in their profession; men who have been selected by their fellows for professional honors. Some such instances have been recorded in these columns, and not so very long ago. Others have come to our knowledge which have not been so recorded.

In defense of such instances, we take it, there will be found no man to speak a word; but why should a man violate in this way even the forms of courtesy? Grant that there is no moral wrong in doing so, if he does not in fact as well as in form report behind the back of the man he is criticizing without giving him a chance to defend himself. So there would be no moral wrong in his walking down Broadway in his shirt sleeves, or refusing to lift his hat to a lady, but he is very apt to be looked on as a cad if he does, and to be held in light esteem. Why should he not be regarded as a professional cad if he persists in saying things about men to their employers which he will not or dare not, at any rate does not, say to their faces? Suppose an extreme case; that after having been called in by A, he finds himself compelled to say such exceedingly unpleasant things about A that he knows B will discharge him. Such a contingency is unpleasant enough at best to a considerate man, and in a sense he might find it less trying to say what he had to say and must say quietly, without saying anything at all to A. But in another and a truer sense he will find this course the most offensive, if he has a nice sense of honor. He will say to himself, "No; if I must say anything at all against A I will say it to his face. I will preserve the outward forms of respect for him at least, or for his office, if not for him. I will give him a chance to know what I am about to say before I say it; to point out any errors in it privately, before I say it publicly, both for my own sake and for his. If I still cannot agree with him I will give him a chance at least to say his say in his own words in his own behalf in transmitting my report, and to enter an appeal from it."

The only rational objection which can be made to this course, is that in some cases it might lead a consulting engineer to be less frank and explicit in his report. But if he does so he is of a more or less cowardly and unworthy temper. Things which such a man would leave unsaid for such a reason were perhaps better left unsaid, because without some such restraint the man who lacks the courage of his convictions may well say more than he is quite sure of, and be sure of more than he really knows. It is one of the strongest points in favor of such an inflexible rule as to the form of reports that, while no man of honor would permit it to make any difference in the substance of a report, it would make him more careful about its form, and more on his guard against cock-sureness. The best of us need some such check against occasional careless lapses from fairness, just as we need the check of some established rules of etiquette against unintentional rudeness. It has been well said that the basis of all such rules is nothing more than respect for the rights and feelings of others, though the connection may not always be apparent. Few are gifted with so nice a sense of courtesy as to do always just the right thing without some rules to guide them. Fewer still are gifted with so nice a sense of professional equity as to say and do always what is in fact fair, if they allow themselves to violate habitually or ever the forms of respect for others.

But if this be true even of the forms of fairness and courtesy, what shall be said of those cases, by no means unknown in high professional circles, though we hope rare—in which both the form and the substance of fairness are violated throughout a professional engagement; in which a call is accepted over the head of the engineer in charge and without his knowledge; in which the latter is systematically ignored and the principals only consorted with; in which a report involving serious charges against his professional work is finally handed in over his head; in which judgment is rendered by non-professionals against the engineer on the strength of that report and his engagement terminated without his being asked or permitted to defend his acts; and in which it finally appears (or does not appear) that grave and palpable errors of fact or theory or both were contained in that report, seriously affecting its substance?

It is asserted that no such instances ever occur among reputable engineers? We will not assert that they have occurred. But we will say that we have strong reason to believe that they have occurred. We will say also, that they may occur at any time, so long as it is considered pardonable for one engineer to report about the conduct of another behind his back. We will say further that so long as this last is true, human weakness may lead many men to be unduly blind to one side of the case, and so work as real injustice, even when conscious bias is wholly absent.

To save ourselves and each other from these dangers; to show that respect for our own profession which we wish others to show to it; to save the morally weak from temptation (and which of us is not morally weak?); to ensure even that we do not unintentionally wrong or wound our brethren, it is time that some outward forms of conventional respect which may not be violated with impuity should be established formally among engineers as they were long ago in the older professions, and as we hold them to be already established in their substance in engineering and every other decent profession. We had meant to speak of two or three other rules of this kind which we think only less important than those named. But we have said enough for the present. We may return to the subject again.

THE TYPE-WRITER IN CIPHER-WRITING.

A curious suggestion in regard to certain possible uses of the type-writer is made by M. Erve, in "Le Genie Civil." It is well known that a favorite form of cipher-writing consists in substituting certain letters for others, each party to the correspondence having the key by which he can place the substituted ones by those intended to be read. M. Erve points out that a secret correspondence of this sort can be carried on very readily by means of any type-writer. All that is necessary is to transpose types on the typebars, so that, for example, touching the key marked A will print C, B will print R, and so on. After one instrument has been so transposed, the other is to be corresponding y rearranged, so that the key C will print A, the key R will print B, and so on. Then X., the correspondent at one end of the line, on receiving a cipher dispatch from the other, Y., has only to copy it on his type-writer. The machine, retransposing the letters automatically, will at once give an accurate translation, while X.'s reply, written on the same type-writer which translated Y.'s original dispatch, will form an unintelligible string of letters, which, by copying on Y.'s type-writer, will be in its turn translated. A cipher correspondence of this kind has an advantage over the ordinary sort, in that the two parties use different, although reciprocal ciphers, and a comparison of dispatches captured from each will give little clue to the meaning of either. Moreover, it would not be very difficult, with some type-writers, which have two space-keys, to make the space-keys actuate types, so that the document would be an uninterrupted string of letters. Such writing is very difficult to decipher, from the impossibility of telling where the words begin or end; yet the corresponding instrument, by mere copying, would translate it perfectly.

Another use of the type-writer which M. Erve suggests is an instrument for shorthand writing. Most stenographers, in addition to the characters for sound, employ a large number of abbreviations and signs, usually of their own devising, which no one but themselves can understand. Hence it comes that stenographers cannot read any one else's writing but their own, and occasionally fail to read that when their use of abbreviations has been too liberal. M. Erve says, very truly, that characters indicating sounds with sufficient accuracy can readily be found in the type-writer alphabet, while a code of abbreviations might easily be agreed upon among stenographers. With such a phonetic system of using the characters, and a reasonable number of abbreviations, it would be easy to write four hundred words a minute on a type-writer, which would be fast enough for the most rapid speaker, while the stenographic writing would have the great advantage of being legible to any other stenographer besides the one who wrote it.—"American Architect."

LETTERS TO THE EDITOR.

TO BRIDGE ENGINEERS.

Sir: It has been brought to my attention that in certain bridge lettings, competitors have stated, or implied falsely, the plans submitted by them had been prepared by me.

I desire, therefore, to give notice to any parties who may thus endeavor to trade upon my reputation that it cannot be done with impunity. Any parties who have plans prepared by me will always have stronger evidence of this fact than their own statements or implication. Theodore Cooper.

New York, Nov. 1, 1892.

CONTINUOUS RAILS.

Sir: I have read with great interest the review of Mr. Moxham's experiments in the last number of Engineering News, and, as going to confirm the position there taken, it may interest you to know that in July, 1891, I saw them laying street car track in Barranquilla, Republic of Colombia, where they used a portable forge and riveted the rails together without the slightest allowance for expansion and contraction. As you are aware, the heat during the day at Barranquilla is something terrible, and is aggravated by the sandy soil, while the nights as a rule are quite cool in comparison and pleasant. I could not see that this method of fastening the rail produced any movement of the track whatever. Neville B. Craig,

Late Chf. Engr. Antioquia Ry., U. S. Col.

Philadelphia, Oct. 30, 1892.

HEAVY HAULING ON PAVEMENTS.

Sir—I notice in your issue of Nov. 3, a note of the hauling of the hub and shaft of a driving-wheel for the Broadway cable railway, and the statement that it crushed the pavement. While I was engaged on the construction of the St. Louis cable railway the following occurred:—

A new cable was ordered, weighing over 105,000 lbs. without the reel. Mr. Meyers, the contractor for hauling it, had a wagon built with 3-ft. wheels and 12-in. tires. The load was hauled six blocks and the wheels had then to be reinforced with pieces of wood inserted between the hub and felloes; the load was delivered, but the wagon was only fit for the scrap heap.

The load and wagon together amounted to a little more than 15 tons per wheel. The effect on Belgian block pavement was to depress it 2 to 3 ins., leaving two distinct furrows in the street. But not a mark was made on the asphalt pavement. Yours truly,

Baltimore, George P. Crehore.

Nov. 5, 1892.

MR. FRIZELL'S FORMULA FOR WIDE CRESTED WIERS.

Sir: I have waited expecting that others would have some comments upon the formula for wide crested weirs, given by Mr. Frizell in your issue of Sept. 29.

The formula is not new, nor, what is more to be lamented, does it seem to be as reliable as the experiments there given would indicate. The formula in question is given in the article Hydromechanics in the last edition of the Encyclopedia Brittannica (p. 472, col. 2) under the form $V = 0.35\ h\ \sqrt{2gh}$ where it requires but the substitution of the value of $\sqrt{2g}$ to give the identical coefficient (3.09) given by Mr. Frizell. But the writer of that article does not seem to see so clearly as Mr. Frizell, the relation which exists between the two depths, for he says that theory gives no relation between them.

But the more important question is as to the reliability of the formula. A formula which could be depended on with anything like the approximation of the Francis formula for sharp crested weirs would be a boon. But in the wide crested weirs experimented on by Francis, the upstream side consists of an inclined plane, about 15 ft. long, and rising about one foot in three. Experiments under these circumstances would evidently be unreliable for the general case of the weir, as the inclined plane makes the conditions entirely special, and would increase the coefficient over the case where the front face is vertical. Such effect is too well known to need more than mention. But the test of the formula is its agreement with experiments.

The only experiments on wide crested weirs with which I am acquainted other than those of Francis, are by Blackwell and Fteley and Stearns. In neither case are the original memoirs at hand, but the tables of results are probably to be trusted. A summary of Blackwell's experiments is given in the same article referred to in the Ency. Brit. Multiplying the values there given by $^2/_3\ \sqrt{2g}$ to make the coefficient comparable we have the following values for the wide crested cases, which are the only ones in question:

Coefficients for Wide Crested Weirs, from Blackwell's Experiments.

	Crest 3 ft. wide.					
Heads in inches	3 ft. long level	3 ft. long fall 1 in 18	3 ft. long fall 1 in 12	6 ft. long level	10 ft. long level	10 ft. long fall 1 in 18
1	2.42	2.92	2.56	....	2.04	2.50
2	2.58	2.93	2.85	....	2.56	2.65
3	2.36	2.87	2.88	2.63	....	....
4	2.24	2.90	2.44	2.66	....	2.76
5	2.56	2.76	....	....	2.78	....
6	2.68	....	2.84	2.71	2.75	2.91
7	2.61	2.75	2 82	2.66	....	....
8	2.52	2.62	....	....	2.51	2.71
9	2.54	2.68	2.67	2 57	2.60	....
10	....	....	....	2 49	2.43	....
12	....	....	....	2.59	....	....

The results of Fteley and Stearns are given in the form of corrections to the depth upon the wide crested weir to give the depth upon a sharp crested weir discharging the same amount of water. Accepting the form of the formula, we would have over two weirs:

$$a\ \sqrt{H^3} = a'\ \sqrt{H'^3}$$

Where H and H′ are the corresponding depths on the two weirs, and taking Francis' coefficient 3 33 we should have $a = 3.33\ \sqrt{\left(\frac{H'}{H}\right)^3}$ from which we may find the corresponding values of "a" from their experiments. Making the reductions we have the following table:

Coefficients for Wide Crested Weirs, from Data Given by Fteley and Stearns' Experiments.

	Width of crest			
Heads. ft.	3 inches.	6 inches.	12 inches.	24 inches.
.10	2.46	2.51	2.51	2.51
.20	2 74	2.58	2.54	2.52
.30	3.06	2.68	2.56	2.53
.40	3.51	2.78	2 58	2.54
.50	....	2 92	2.62	2.55
.60	....	3.08	2.66	2.56
.75	....	3.26	2.74	2.57
1.00	....	....	2.92	2.61
1.20	....	....	3.08	2.65
1.40	....	....	2.22	2.70
1.50	....	....	3.30	2.74

In both cases the reductions have been made by the slide rule, so that errors may be expected, in the last place at least. Not having the original memoirs at hand, it is possible that the tables are used in a way which they will not warrant. But the agreement between the two sets of experiments strengthen each. The coefficient manifestly falls far short of the 3.09, except when the depth is nearly equal to the width of the weir, a case which is recognized as undesirable with the sharp crested weir, and which will not be met with except for very short weirs.

It would therefore seem that the agreement with the discharge in the experiments of Francis is due to the special conditions of the inclined approach, which, as is well known, would increase the discharge and therefore the coefficient. As the object of Francis was to measure the discharge over a weir of the same section as the dam across the Merrimack River, his experiments were limited to this form. Very truly yours,

L. G. Carpenter

Fort Collins, Colo., Oct. 25, 1892.

(We observe to one of the quantities in a part of Blackwell's table not quoted above (Encyc. Brit. "Hydromechanics" p. 473) the following note: "The discharge varied from .461 to .665 cu. ft. in two experiments. The co-efficient (given) is derived from the mean value." The mean of two observations standing to each other as 100 to 70 is not very close work, and the range of the Blackwell tests as to constants was rather small. Moreover, is it not true of both the tables above that on the whole they indicate that as the head becomes large (i. e., over a foot, which is large only in such tests) and the weir long, the influence of width and slope of crest, becomes evanescent? The Fteley-Stearns tests, however, plainly indicate that the co-efficient should be greater than 3.09, if correctly made and tabulated.—Ed.)

MILL BUILDING CONSTRUCTION, WITH DETAILS FROM PRACTICE.*

(With inset.)

The writer wishes to present, for your consideration and discussion, a brief statement of the more important conditions which should govern the design and construction of modern mill buildings. The general dimensions of the building, in any given case, are determined by the use to which it is to be put, while the sections of its members depend upon the strains, due to the various loads it is called upon to withstand.

General Types of Buildings.—There are three general types in common use. The first has a rigid iron frame throughout. Each transverse bent is made up as follows: An iron roof truss is supported at its ends by iron columns firmly anchored to masonry piers. The bent is made rigid by transverse bracing, consisting of knee braces in intermediate bents and vertical bracing in the end bents between columns. In the sides of building vertical bracing is provided between the columns and lateral bracing in planes of top and bottom chords of trusses. When long panels are desired, the alternate roof trusses can be supported on longitudinal girders or trusses running between the columns. At the ends of the building one or more gable columns should be introduced to shorten the unsupported length of transverse vertical bracing. The sides and ends may be covered with corrugated iron sheeting supported on suitable framework.

The second type differs from the first in having thin curtain walls of brick, built up to the top of columns on all sides of the building. These walls carry no verti-

* A paper by George H. Hutchinson, Assoc. M., Am. Soc. C. E., read before the Engineers' Society of Western Pennsylvania.

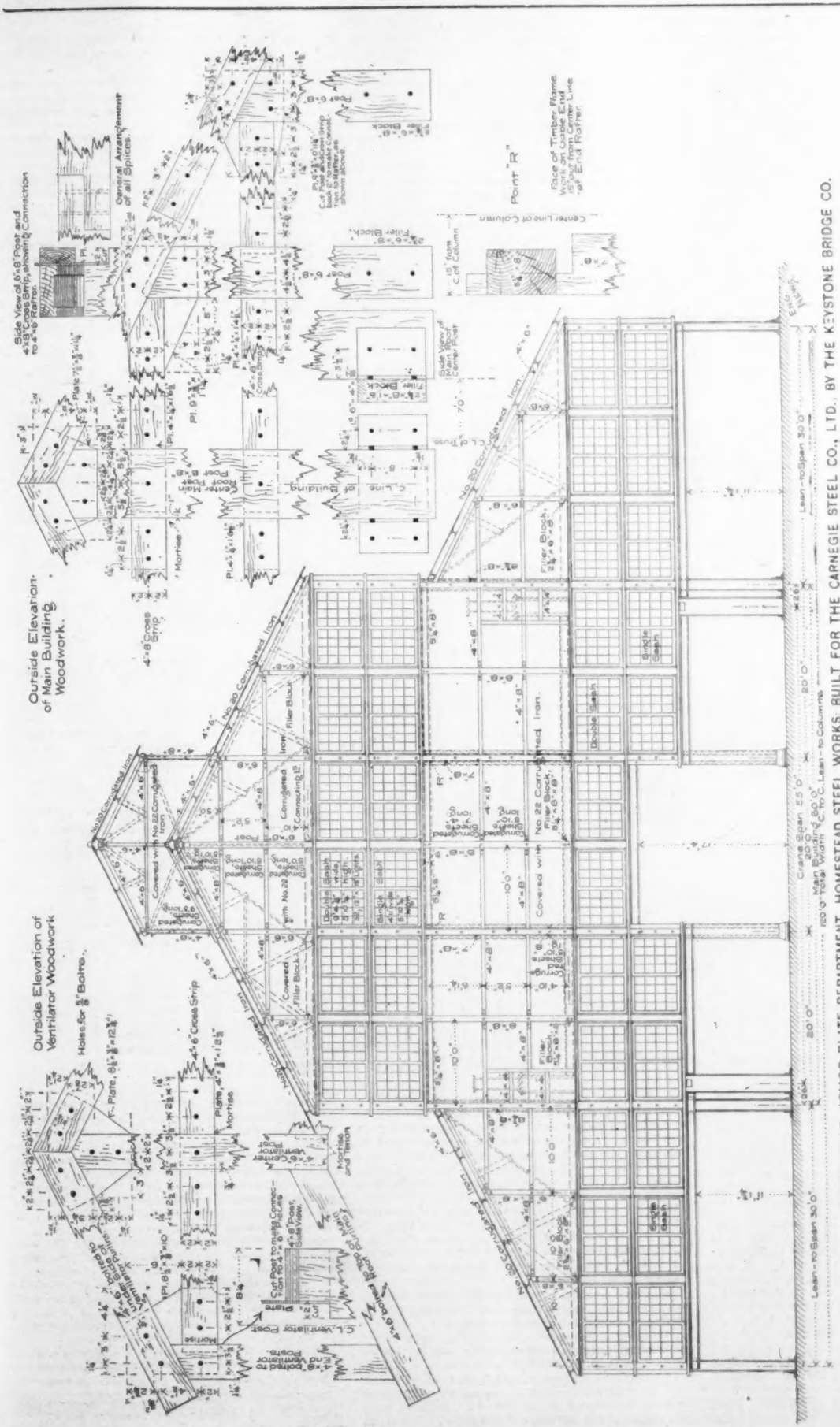

Outside Elevation of Main Building Woodwork.
Outside Elevation of Ventilator Woodwork
Point "R"
Face of Timber Frame Work on Gable End 15' Out from Center Line of End Rafter
Center Line of Column
Side View of 6"x8" Post and 4"x8" Cross Strip, showing Connection to 4"x6" Brace
General Arrangement of all Splices
Side View of Main Roof Center Post
Cut Post to Ridge Connection from No 4"x8" Post, Main Work
Cut Post to Ridge Connection from No 4"x6" Post, Ventilator Work
Plate
Mortise
Mortise and Tenon
Holes for 5/8" Bolts
Cross Strip
Filler Block
Double Sash
Single Sash
No 22 Corrugated Iron
No 20 Corrugated Iron
Crane Span 25'0"
Main Building 60'0"
Total Width 120'0"
C. to C. Lean-to Columns
Lean-to Span 30'0"
Lean-to Span 30'0"
20'0"
20'0"
10'0"
10'0"

PLATE IV. PRESS SHOP, ARMOR PLATE DEPARTMENT, HOMESTEAD STEEL WORKS; BUILT FOR THE CARNEGIE STEEL CO., LTD., BY THE KEYSTONE BRIDGE CO.

(End Elevation of Building Shows Position and Size of Timbers for Corrugated Iron Connections.)

cal loads, but must do the work of the vertical bracing between the columns in the sides and ends. This bracing is therefore omitted; but there should be in the sides of the building a top strut running from column to column, and connecting to the inner flanges, in order to clear the brick wall. If desired, the top strut may connect on the center line of columns, in which case the wall may be built around it.

Buildings of the first type of construction are suitable to withstand the action of the heaviest jib and traveling cranes, since they are able to resist large horizontal forces, as well as the usual vertical loads. The second type, while suitable for buildings of heavy construction and especially adapted for machine shops, is not so well fitted to endure the action of cranes of large capacity, particularly if the building be high and narrow. If for any reason the brick walls are considered essential, and it is desired to secure the greatest strength and rigidity possible, regardless of expense, a combination of these two types would give a result which could not be surpassed.

The last type of construction to be mentioned is well adapted to buildings intended for heavy machinery and light jib cranes, and may be used for suspended traveling cranes. In this third type there are no iron columns. The walls of the building are brick, and the roof trusses rest directly upon them. Additional rigidity can be secured by the introduction of iron columns at the four corners of the building. These columns should be well anchored to the foundations. The roof trusses should be braced in the planes of the top and bottom chords. If there are no jib cranes for which to provide, the bottom chord bracing may be put in alternate panels only; in which case, however, the top chord bracing should be in every panel to keep the walls in line.

Classification of Forces and Their Action.—At this point it may be well to state, at some length, the character of the loads and forces which come upon a mill building, examine the action of these loads upon the structure, and determine the provisions necessary to withstand them. To ascertain the amount of the dead and live loads, and find the stresses resulting therefrom is an important question, by no means easy to solve, as will be readily seen from what follows. For convenience in treatment, the forces to be considered will be grouped under two heads —vertical loads or forces and horizontal forces.

Vertical Loads or Forces.—Under this head come the weight of the iron frame and its covering, the weight of snow, the vertical component of the wind, traveling cranes and their lifted loads, the weight of pipes, machinery and shafting, the action of driving belts, and such additional loads as may arise in individual ca es. The importance of considering the action of stres es due to cranes is evident, when we consider there are now in use jib cranes of varying capacity up to 50 tons and traveling cranes up to 100 and even 150 tons' capacity. These cranes produce not only direct stresses in main members and bracing, but also heavy bending moments in the columns,and alternating stresses in various members throughout the building. The action of long lines of shafting with their driving pulleys and belts, and of hydraulic and steam machinery frequently contribute a large share to the sum of uncertain, and, too often, unconsidered stresses, to which a mill building is subject. While it is impossible to determine these stresses with accuracy, it is nevertheless necessary to make allowance for them; and the proper way to deal with them is to assume, as nearly as may be, an equivalent uniform load and a single concentrated load, which may be applied at will to any member of the structure. These vertical loads vary so in amount, depending on the span and type of building, that it is impossible to give any equivalent load per square foot which could be used indiscriminately. It must be ascertained independently for individual cases. The action of the vertical loads on the structure is readily determined and need not be further discussed.

Horizontal Forces.—Under this head come the horizontal component of the wind and the thrusts from the traveling cranes, jib cranes, belts, etc. The horizontal action due to the cranes and wind is of considerable importance, and is an element which, perhaps, does not receive the attention it merits. Fortunately, however, the maximum wind and the maximum crane loads occur but rarely, and the probability of their occurring simultaneously is so small that if we proportion each member for the larger, we may disregard the smaller. Horizontal forces act on a building, tending to move the structure horizontally and to overturn it as a whole. As a result, stresses are produced in the individual members throughout the building. Friction and the weight of the structure are usually sufficient to counteract the tendency to movement, and we need consider only the action on the individual members. This action can be best shown by means of a stress diagram, Plate II., Fig. 1.

The following conditions will be assumed, the ing to consist of a rigid iron framework throughout, with dimensions as follows:

	Ft.	Ins.
Height to center line of bottom chord of roof truss	42	6
Rise of roof truss	16	0
Height of ventilator	7	6
Total height of building	66	0
Span of building, center to center of columns	64	0

Wind force will be taken at the low value of 20 lbs. per sq. ft. The wind will be assumed to blow in a horizontal direction in all cases. The vertical dead load, acting on columns, of 25 lbs. per sq. ft., horizontal projection; with an additional vertical loading, acting on columns, of 25 lbs. per sq. ft., horizontal projection. These two loads cover the weight of the iron framework of the structure; the roof load being the weight of the trusses and their covering, and the additional column load being the weight of the columns and their bracing. The permanent loads only have been selected for analysis, so that the liability to alternating wind stresses in the roof trusses may be fully shown; at the same time, the dead weights have been taken quite as large as will occur in practice, and in the majority of cases they will be considerably smaller than those assumed. Thus it will be seen that an extreme case has not been taken.

Were we designing the building for actual construction, it would be necessary to assume, in addition to those already mentioned, vertical loads something like the following: For snow, 10 lbs. per sq. ft.; for equivalent uniform load, 10 to 15 lbs. per sq. ft.; for concentrated load, 10,000 lbs.

The equivalent uniform load and the concentrated load above mentioned, are loads referred to in the paragraph relating to vertical forces, and cover the action of shafting or other indeterminate loads, which would affect the building, their amounts depending upon the use to which it were to be put. If cranes were to be put in the building, their action would also have to be considered. For the purposes of our discussion, these loads need not be included in our analysis. Analyses have been made for the five cases named below.

The diagrams on Plate I show:

Case 1. The stresses in roof trusses, columns, and knee braces, for wind acting on one entire side of the building and roof, column hinged at base.

Case 2. The same conditions of loading, columns rigidly fixed at base by anchor bolts.

Case 3. The stresses in roof trusses and columns, for permanent dead load.

Case 4. The stresses in roof trusses, for wind on the roof only. The roof trusses rest on wall and are anchored at both ends.

Note.—For cases 1, 2 and 4, the entire horizontal force of 20 lbs. per sq. ft. is considered on the vertical projection of all surfaces acted on by wind. The vertical component is disregarded.

Case 5. The stresses in roof trusses, columns and knee braces, for wind acting on one entire side of building and roof, for columns rigidly fixed at base by anchor bolts.

For case 5 only, the resultant action of the wind is considered to be normal to the roof surface. It is customary to consider the resultant wind pressure as acting normally to the roof surface; we have, however, in the present instance, for the purpose of comparison, found the stresses resulting from the normal pressure, and also from the full horizontal force of the wind acting on the vertical projections of the building. In the latter case there will be no vertical component. When the resultant normal pressure is considered, as in case 5, the wind stresses may be found in one diagram for this normal pressure, or the stresses for the horizontal and vertical components may be found separately, and combined for total wind stresses.

Cases 2 and 5 show a comparison of the effects of normal and horizontal wind pressure. All the conditions in these two cases are the same, except that of the direction of the resultant pressure of the wind. In high buildings with ventilators, on account of the small proportions of exposed roof area; the difference in stresses is not very marked; the resultant normal pressure giving in most members the smaller results.

According to Unwin, the formula* $P = F \sin. i. 1.84 \cos. i - 1$ deduced from Hutton's experiments expresses the relation, for wind blowing horizontally, between the

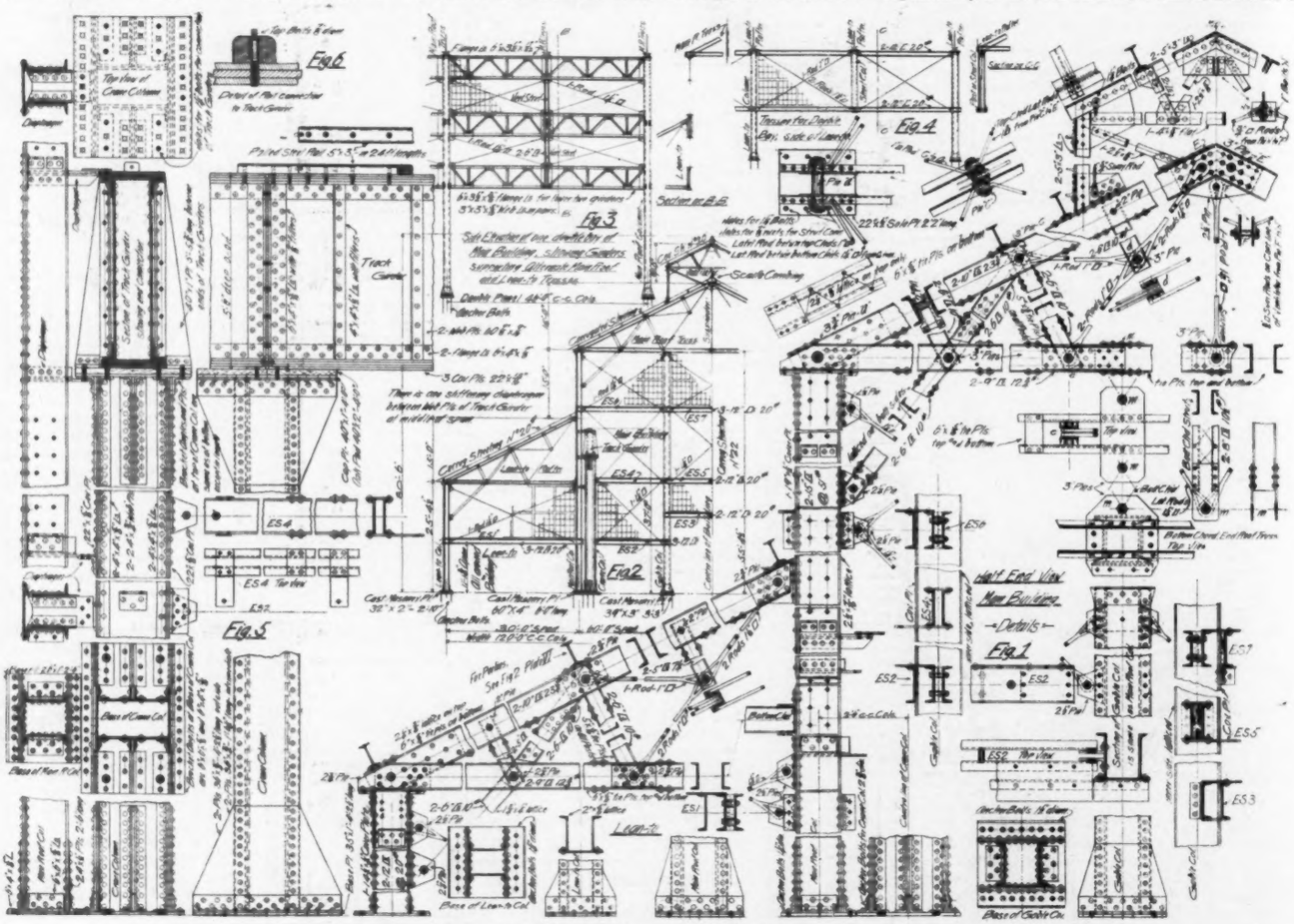


PLATE V. DETAILS OF IRON WORK IN PRESS SHOP, ARMOR PLATE DEPARTMENT, HOMESTEAD STEEL WORKS.

* For clear explanation of this formula see Greene's "Graphical Analysis for Roof Trusses." John Wiley & Sons.

horizontal force of the wind on a vertical plane and the normal pressure on a surface inclined to the horizon.

In this formula:

F = the horizontal force of the wind on a square foot of a vertical plane, placed at right angles to the direction of the wind.

P = the resultant normal pressure of the wind on a square foot of the surface of a roof inclined at an angle i° to the horizon.

The following table gives values of P, derived from the above formula for various inclinations of roof surface, for wind blowing horizontally exerting a pressure of 10 lbs. per sq. ft. on a vertical plane.

i° = Angle of roof surface with horizon :

5° 10° 15° 20° 25° 30° 35° 40° 45° 50° 55° 60°.

P** = Resultant normal pressure per sq. ft. of roof surface:

1.3 2.4 3.5 4.57 5.62 6.52 7.52 8.35 9.02 9.52 9.90 10.0

The intensity of the wind stresses throughout the roof truss is dependent, other conditions remaining constant, upon the ratio between the total length of the column, and the length of the portion above the foot of the knee brace. The greater this ratio, the greater will be the stresses.

Although the knee braces have been assumed of greater depth than will ordinarily occur in practice, an examination of the diagrams will show for cases 1 and 2, and even for case 3, that the wind stresses in some of the principal members of the windward side of the roof trusses are equal to the dead load stresses, while on the leeward side the stresses are of opposite character and of even greater intensity. Note especially the stresses in the top and bottom chords of the roof trusses and the two main diagonal ties running to the ridge, also in the knee braces and the adjoining diagonals.

The analysis for the horizontal action of crane loads is similar to that given for wind, except that it is simpler, as there are fewer loads to deal with, therefore it is not necessary to give the analysis for this class of forces, but in practice the maximum stresses arising from either wind or crane loads should be provided for, considering such part of crane load as may be deemed proper for bent under consideration.

Systems of Bracing.—Mill buildings should be thoroughly braced to resist the action of horizontal forces and to keep them properly lined up. For this purpose vertical longitudinal and vertical transverse bracing and lateral bracing are required.

Ventilator Bracing.—There should be a strut running from top of each ventilator post to apex of main roof truss, to prevent distortion of ventilator frame. Vertical longitudinal bracing is needed in sides and at center line of ventilators, to keep the frames upright and parallel. When swinging windows are placed in sides of ventilators the bracing in sides must be omitted, and stiff bracing fastened to the ventilator purlins should be used.

Rafter Bracing.—The purpose of this bracing is to keep the trusses from overturning, and it should be strong enough to resist the action of the wind on the gable end of the roof. This bracing may be placed in alternate bays only.

Bottom Chord Bracing.—The purpose of this is to keep the columns in line and to distribute concentrated loads.

Vertical Bracing Between Columns.—The purpose of this bracing is to transmit to the foundations all stress is due to horizontal forces. The greater the depth of this bracing, for given length of column, the less will be the resulting stresses in the columns, trusses, and in the bracing itself. Usually it may come down to a point 8 to 10 ft. from the ground. The bracing in the sides, takes the longitudinal thrust of the wind and crane loads, and the bracing in the ends resists that part of the transverse action of the wind and crane loads received from the bottom chord bracing.

It will be well to consider, in a general way, the action of the wind and crane loads on these systems of bracing in the sides and ends of a building. Both of these classes of forces, if allowed, would act on the structure in the same general manner; but the different conditions under which they are applied seem to warrant the provision of separate systems of bracing to transmit them to the foundations. It would be impracticable in long buildings to make the bottom chord bracing heavy enough to carry the cumulative wind loads from the successive panels to the ends of buildings. It is, therefore, necessary that each intermediate bent should resist its own wind load and a portion of the distributed crane loads. To do this, knee braces are provided at each bent running from bottom chord to column. The conditions of head room allow the knee brace to extend down the column a short distance only, and the resulting stresses from the wind, as has been shown in the diagram, are large in the trusses and column and in the knee braces themselves. These members should, therefore, be made abundantly strong to resist these stresses. The uniform wind loads having been provided for, the crane loads and other local loading only remain to be considered. The bottom chord bracing must take these loads and distribute them to the adjacent bents, transmitting the residue, if any, to the vertical bracing in the ends of the building. This is an economical arrangement, since the maximum crane stresses occur simultaneously in two or three panels only, and consequently are not seriously cumulative. Crane stresses are occurring constantly, and their repeated action would be a severe test upon the rigidity of the structure, if each bent were to resist the stresses from loads in the adjacent panels. On the other hand, large wind loads occur rarely, and the individual bent can withstand them without injury.* We do not mean to say that in practice the wind will be taken by the individual bents and the crane loads by the bottom chord bracing, because there is necessarily great ambiguity in the distribution of these loads; but the bottom chord bracing will have served its purpose if it relieves individual bents of the racking effect of concentrated loads.

Action of Horizontal Forces on the Columns.—The column in resisting horizontal forces, acts as a beam, and when rigidly anchored it may be considered as fixed in direction at the base; but when not properly anchored, it must be considered as hinged at the base, or in other words, free to rock on the pier. Theoretically, we might consider the column as fixed in direction at the top also, when rigidly connected to the roof truss; but as we are not at all sure of realizing a sufficient degree of rigidity at this point, it will be safer to consider the column simply supported at the top in all cases. In reality, there would be but little gain in fixing the column in direction at the top, as it must be done at the expense of resulting bending moments in the roof truss. The column, then, in resisting horizontal forces, will, when rigidly anchored at the base, act as a beam fixed at one end and supported at the other;* but when not properly anchored, it will act as a simple beam supported at both ends. The anchor

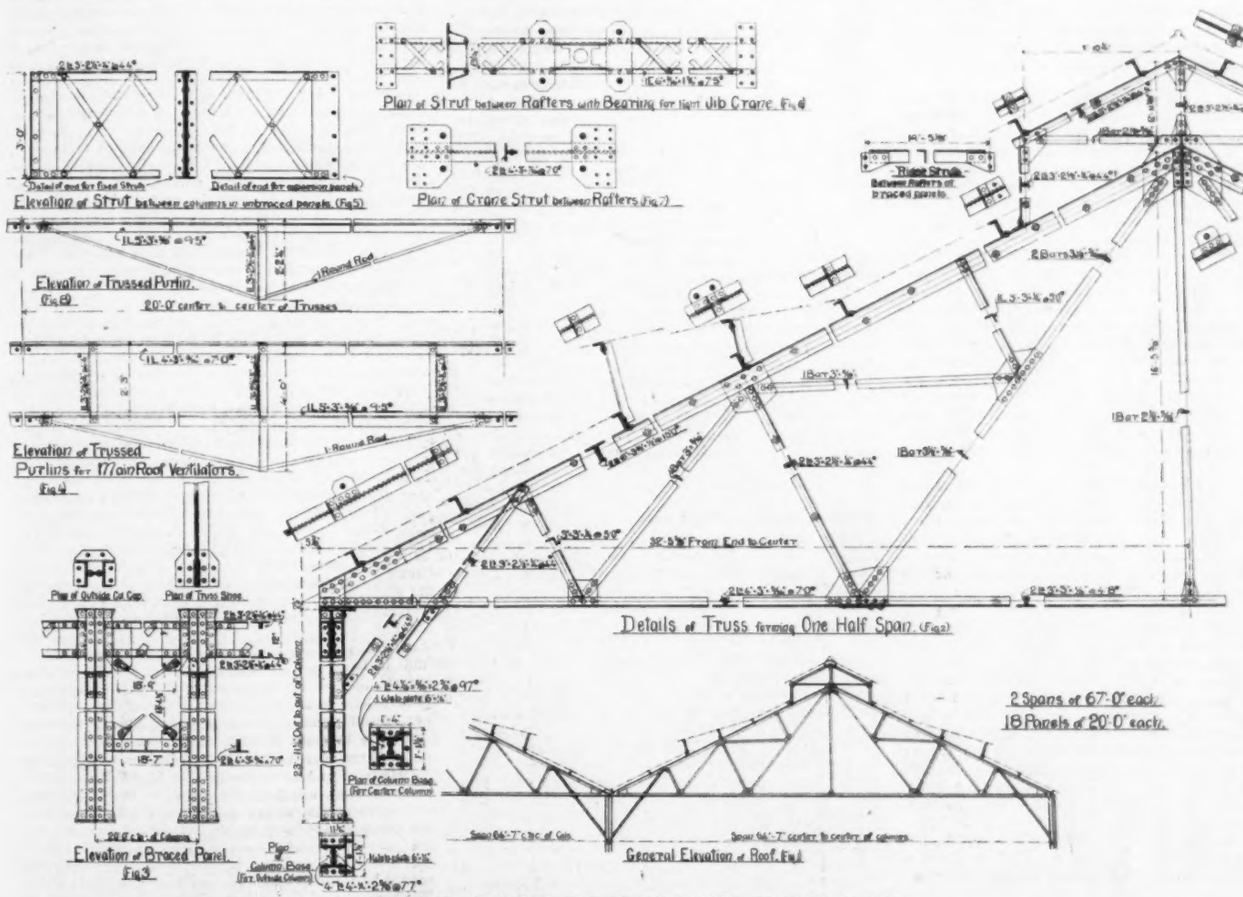

Plan of Strut between Rafters with Bearing for light Jib Crane. Fig 6
Plan of Crane Strut between Rafters. (Fig 7)
Elevation of Strut between columns in untraced panels. (Fig 5)
Detail of end for Knee Strut
Detail of end for upper end of purlin
Elevation of Trussed Purlin. (Fig 8)
20'-0" center to center of Trusses
1 Round Rod
Elevation of Trussed Purlins for Main Roof Ventilators. Fig 4
Plan of Gutter Cut Cap
Plan of Truss Shoe
Elevation of Braced Panel. Fig 3
Plan Column Base (For Gable Columns)
Plan of Column Base (For Center Columns)
Details of Truss forming One Half Span. (Fig 2)
Ridge Strut
Between Rafters of Braced panels
2 Bars
1 Bar
38'-5" From End to Center
2 Spans of 67'-0" each.
18 Panels of 20'-0" each.
General Elevation of Roof. Fig 1

PLATE VI. BUILDING FOR BENDING SHOP OF TUBE WORKS.

**A graphical diagram for the value P derived from the above formula is given in Howe's "Diagrams, Formulas and Tables for Bridge Engineers and Architects." Reprint from "Mechanics," 1890, for private circulation.

* In the analysis of this case, the column has been considered as a beam with level supports; strictly, this condition will not be realized, for, as the top of the column deflects to the leeward, the support at that end will be depressed an equal amount and the resulting stresses will be somewhat larger than found by the analysis. However, this increase is, in a measure, counteracted by the partial condition of fixedness at top of column, which has been disregarded in the analysis.

bolts in fixing the columns have to resist the bending moment at the base, or, in other words, they must counteract the tendency of the column to rock on the pier. They must also resist the horizontal thrusts not overcome by friction. The rocking tendency is influenced by the width of column base and by the depth of the vertical bracing.

The lower the bracing extends, the smaller will be the bending moment at the foot of the column and the less the pull on the anchor bolts. If the bracing were to extend the entire length of the column, the bending moment at the base and the pull on the anchor bolts would be reduced to zero. In practice, the bracing can run down the column a short distance only, and bending moments will occur at the foot of the bracing, and at the base of the column. As a result, the column, acting as a beam, will be distorted, and a point of contra-flexure will occur in the unsupported portion. If the anchor bolts be removed, the case will be a beam supported at both ends. The point of contra-flexure will then disappear and the bending will be largely increased.

From this discussion we observe the following important fact: Deep bracing and strong anchorage reduce the strains in the columns, roof trusses and the bracing itself. In designing the column, the moments at the base and at the connection of the bracing should be provided for in the section. The anchor bolts should be made of sufficient section to thoroughly fix the column at its base.

Types of Roof Trusses.—While there are several types of roof trusses well adapted to mill building, probably the one in most common use is the French roof truss, so called. This truss is simple in design and suitable for either light or heavy construction. For several other types frequently used, see Plates I. and II. Whatever the type, it is always best to make the bottom chord of the truss straight, except when the conditions of head room require it to be raised.

Sections and Details.—Irrespective of the type of roof trusses, there are two radically different styles of construction which may be used: one is pin-connected, and the other is riveted work throughout. While there is a large variety of sections from which to choose in the riveted style, the T-shaped section is most commonly used. This is composed of two angles placed back to back, with or without a single web plate between. This form of section may be used for both tension and compression members. A single flat bar may be used for the smaller tension members. Roof trusses built in this manner lack somewhat in rigidity and lateral stiffness.

In the all-iron type of building—that is, where the roof trusses rest directly upon the column—rigidity and stiffness are important factors, and the construction shown in Fig. 1, Plate V., is frequently used with satisfactory results. In this, all the compression members are made up of two channel bars turned back to back and latticed, forming a box section. For members subject to tension only, loop-eye rods are used. The truss is pin-connected throughout. Upon examination of the figure it will be observed that all the connections are readily made and that the details are simple in design. But little riveting is required;—the shop work can be easily and quickly turned out;—and the building rapidly erected in the field. The bottom chords of the trusses will stand heavy loads in bending and afford especially good connections for jib cranes and lateral bracing. The roof trusses have such strength and rigidity as to impart stiffness to the entire building. This style of construction is well adapted to both light and heavy buildings.

There is another style of construction suitable for heavy work only, which is quite as rigid as the one just mentioned. In this, the top and bottom chords are of box sections, and made up of plates and angles instead of channels. The web members have an I-shape, and are made up of four angles placed back to back in pairs and latticed. All the truss members are stiff, and may have either pin or riveted connections.

When these built sections are used with riveted connections; the shop work is somewhat less expensive than for pin-connected channel construction. But when pin-connections are used for both styles of constructions, the channel sections require less shop work, and afford simpler details than the built sections.

Roof columns and light crane columns may be constructed of Z-bars, channels, or plates and angles; but for simplicity of details, the channel columns are to be preferred to all others. For heavy crane columns, however, it may be necessary to use plates and angles, to secure a column of sufficient width.

Referring again to roof trusses:—whatever style of construction is used, the following points should be well considered: The trusses must be designed to withstand the maximum stresses produced by any possible combination of vertical and horizontal loads, or by the vertical loads alone. The bottom chords of trusses should be made stiff enough to take both the tension and compression to which they are subjected, as well as the bending from local loads. They must afford a convenient connection for the longitudinal struts in the bottom chord bracing, and, in fact, they are themselves important struts in that system of bracing.

Columns and Girders for Traveling Cranes.—Track girders for light traveling cranes may be supported on brackets on the roof columns, but as this arrangement gives an eccentric loading on the columns, it is better for heavy cranes to provide a separate column to carry this load. To prevent unequal settlement, the crane columns and roof columns should stand on the same base. The connection between these columns should be rigid, so that as far as possible they may act as one member. The girders must be thoroughly connected to the crane columns and braced laterally to the roof columns. Knee braces from crane columns to girders give longitudinal stiffness. For track girders, I-beams or plate girders are preferrable to lattice girders. Long, heavy girders should have the box section, with diaphragms at intervals between the webs. See Plate V., Fig. 5.

Rails for Track.—In order that the alinement of the track be true, it is best to drill the holes for rail fastening with girders in position and the rails lined up. Oak packing is frequently put under the rails and at the girder seats to insure smoothness in the running of the cranes. Several rail sections with method of fastening are shown on Plate II. Details of crane columns and track girders are shown on Plate V., Fig. 5.

Splices and Connections.—Members subject to tension and compression should have their splices and end connections made to resist the maximum stresses of both kinds. When bending stresses occur, they should be considered in designing the splices; this necessitates both flange and web splices. As an example, the splices in the bottom chord of the roof trusses should be able to develop the full strength of that member in tension, compression and bending. The splice at the ridge of the roof truss has to resist the horizontal thrust from the rafters and any vertical shear which may arise from unsymmetrical loading. It is well to remember that the wind is an important case of unsymmetrical loading. In addition, provision must be made to introduce into the rafters the stresses from the web members which meet at this point.

The connection of roof trusses to columns has to resist large horizontal and vertical stresses. In the analysis given for wind in Case 1, shown on Plate II., the horizontal shear on the leeward side is 40,000 lbs. and the upward pull from the roof truss is 22,000 lbs.; which gives a resultant of about 46,000 lbs. to be resisted by the connection. This resultant is net, that is, exclusive of the 25,000-lb. dead load from the rafter. On the windward side there occurs a resultant of 55,000 lbs. from wind alone, or 70,000 lbs. from wind and dead loads combined. The style of connection determines whether, on the windward side the larger or the smaller resultant should be provided for.

Column Bases.—The gusset plates and bracket angles at the foot of the column have several important duties to perform, which require them to be thoroughly connected thereto. They assist in distributing the column loads to the base plate; they give stability to the column by broadening its base, and furnish a connection for the anchor bolts. The base plate should be large and strong enough to distribute to the pier the loads received from the enlarged column base. The anchor bolts should pass through the bracket angle and, at the same time, be placed as far from the center line of the column as practicable. They should be anchored in the masonry sufficiently to develop the full strength of the bolts. Large anchor bolts should be built deeply into the masonry; small anchor bolts, however, may be roughened or split and wedged and set in drilled holes, with hydraulic cement, lead or sulphur. See Plate II., Fig. 1.

Piers.—The masonry piers for supporting the columns should be of sufficient dimensions, weight and strength, to resist the vertical loads, the horizontal thrust and the overturning action from the column. They should extend well below the frost line and reach a firm bottom. If necessary, concrete or piles may be used to secure a suitable foundation. To secure a uniform distribution of the column loads, the piers should be provided with a cap consisting of either a single stone or a cast-iron plate. If the stone be used, it should be large enough to give a margin all around the column base, equal to one-third of its thickness, which latter should be at least one-third its largest dimension.

Purlins.—For roof purlins, angles, Z-bars or I-beams may be used, with or without trussing. Single channels do not have sufficient lateral stiffness to make good purlins. Several styles of trussed purlins are shown on Plate III., Figs. 1, 2 and 3. Fig. 2 shows a simple and desirable style of trussing, using star shapes and flat bars. Fig. 1 shows a good section for a long and heavily loaded purlin, made up of two channels, forming a box section and held together by tie plates. Loop-eye rods are used in the trussing, which is pin-connected. Care should always be taken to turn the shape used as a purlin so as to secure the greatest vertical depth. Plate III., Figs. 5 and 6, show the correct and incorrect method of placing the purlin upon the rafter. Fig. 5 also shows the method of bracing I-beam purlins to rafter, by the use of bent plates. Purlins act as longitudinal struts in the system of rafter bracing. At the ridge, under ventilator, no purlins are required. It is, therefore, necessary to have a ridge strut to complete this system of bracing. Long purlins are liable to sag in the plane of the roof. Plate III., Fig. 4, shows a method of holding them in place by tie rods between the purlins, running from ridge to eaves.

Expansion.—Roof trusses resting on brick walls should have one end free for expansion. A wall plate, for a sliding surface, should be used for spans to about 75 ft., and rollers should be provided for larger spans. Roof trusses resting on columns must be attached rigidly thereto, no provision being made for expansion. It is customary to introduce expansion panels in long buildings at points 100 to 150 ft. apart, to provide for longitudinal expansion.

Corrugated Iron Sheeting.—The use of corrugated sheeting to close the sides and ends of buildings where brick walls are not present, has already been mentioned. It is used, as well, for a roof covering and has the advantage of being cheap, light in weight, and incombustible. Furthermore, it is quickly and easily put on and readily renewed. Its most objectionable quality is its liability to rust. This can be retarded if the sheeting is kept well painted on both sides, and still further by using galvanized sheeting. Common weights of sheeting for roof are Nos. 18 and 20, and for sides of building Nos. 20 and 22. For No. 20 sheeting, purlins should be spaced not over 6 ft. c. to c., and preferably less than this.

Lighting and Ventilation.—Ample provision should be made for lighting and ventilation. Windows with swinging, sliding or fixed sash, may be introduced in the sides and ends of the building and in the sides of ventilators. Louvres for ventilation may replace the windows where desired. Additional lighting surface can be obtained by the introduction of skylights on the main and ventilator roofs. In the sides of a building which has brick walls it is a simple matter to provide openings for windows and doors. In buildings with no brick walls, framework between the columns is necessary to support the doors, windows and sheeting. This framework may be all timber, all iron, or a combination of iron and timber. The framework entirely of timber is suitable for light buildings only. The framework entirely of iron is required in buildings where combustible material is prohibited. In the latter, the bracing and framework supporting the windows are of structural iron, and the window frames and sash are galvanized iron. An all-iron frame for a gable is shown on Plate III., Fig. 7. The combination timber and iron framework is suitable for all buildings where absolute fire-proof construction is not needed. In this case, we have a complete system of iron bracing between the columns. The main girts are of iron, but the girts and posts supporting the windows and corrugated iron are of timber and are introduced between the main girts wherever needed. This style of construction is shown on Plate V. In the all-iron type of construction, the bracing between the columns is frequently stopped 8 to 12 ft. above the ground. The space below the bracing may be left entirely open, or closed with corrugated sheeting and swinging, sliding or lifting doors.

General Conclusions.—In the design of mill buildings of the present day, it seems to the writer that there are certain stresses incident to the everyday operation of the mill, which do not receive proper recognition. We can with profit make a comparison of the design of the mill building with that of the railroad bridge, since in general the same principles apply to both. In the latter, provision is made for certain secondary stresses, such as impact, wind and centrifugal force. In addition, the probable increase in loading during the life of a structure is considered. In like manner, we have in the mill certain secondary stresses due to the action of cranes and wind, equal in importance to those above. The question of the future increase in loading of the mill building should be given the same attention as it receives in bridge construction. We have already considered the action of these secondary forces upon the building and have shown that they must be provided for in order to secure rigidity, which can be accomplished only by the use of liberal sections and suitable bracing. The uncertainty respecting the increase in loading which future conditions may dictate for the structure, is especially marked in the case of extensive plants, in which, on account of radical development, radical changes are not unusual. While the writer would not be understood to advocate the introduction of material in members throughout the structure regardless of their present or probable future requirements, he does hold that in the long run it is economy, in the case of permanent structures, to provide not only for loads which it is known will occur, but for those which experience teaches are within reasonable range of possibility. The objection to all this is that it costs money, but small first cost is not always true economy. A cheap building will in time cost enough for repairs and remodeling to make it an expensive investment. Furthermore, delays in the operations of the mill, which are liable to result from weak and faulty construction, are expensive drawbacks, and frequently are far-reaching in their consequences.

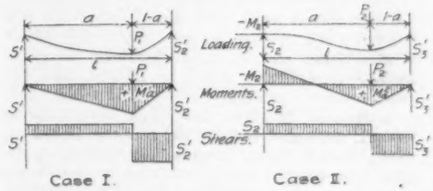
A principle well worth noting, and one which argues strongly in favor of designing for liberal loads, may be stated in this connection: After the material has been provided to make a structure strong enough to carry a moderate loading, the introduction of extra material will give an increase in carrying capacity which is entirely out of proportion to the expense incurred for such increase.

In conclusion: we may say that the three most essential factors in the design and construction of mill buildings, named in the order of their importance, are strength, simplicity and economy.

The accompanying plates represent several types of structures, recently erected in the vicinity of Pittsburg. The author is indebted to the courtesy of the management of the Keystone Bridge Works, for the drawings of work constructed by them, from which the details were selected. The plates are largely self-explanatory and need no further description in the text. The author is also indebted to Chas. H. Nichols, C. E., and Harold C. Stowe, C. E., for valuable assistance and suggestions in the preparation of this paper.

APPENDIX.

Analyses for Wind.—The following is a brief statement of the conditions assumed and the methods employed in making the analyses for wind stresses. The reactions, shears and moments are determined analytically; the resulting stresses in the knee braces and roof trusses are determined graphically, as shown on Plate II.



Nomenclature: Known Terms:

l = length of beam or column k. $= \frac{a}{l}$.

a = distance from base of column to the foot of knee brace, or to the point of application of the load P_1 or P_2.

S_1 = horizontal component of reaction or shear at base of column when hinged at the base. Case I.

S_2 = horizontal component of reaction or shear at base of column when fixed at the base. Case II.

$S_1 = S_2$.

Unknown terms:

$S^1{}_2$ = shear at top of column when hinged at the base.

$S^1{}_2$ = shear at top of column when fixed at the base.

P_1 = horizontal thrust or load at the foot of knee brace, due to the leverage action of the column when hinged at the base.

P_2 = horizontal thrust or load at the foot of knee brace, due to the leverage action of the column when fixed at the base.

$M^1 x$ = bending moment at any section of column distance x from the base, for column hinged at the base.

$M^2 x$ = bending moment at any section of column distance x from the base, for column fixed at base.

$M^1 a$ = bending moment at foot of knee brace = max. moment when the column is hinged at the base.

$M^2 a$ = bending moment at foot of knee brace = maximum moment when the column is fixed at the base.

M_2 = bending moment at base of column, for column fixed at base.

V_1 = vertical reaction at either column, due to the overturning action of the wind on one entire side of the building and roof, for columns hinged at the base.

V_2 = vertical reaction at either column, due to the overturning action of the wind on one entire side of the building and roof, for columns fixed at the base.

b = span of roof.

Formulas.

Case I. For columns hinged at the base and considered as a beam supported at both ends.

(1). $S^1{}_2 = \frac{S_1 a}{l-a}$

(2). $P_1 = \frac{S_1 l}{l-a}$

(3) $M^1 x = S_1 x$ when x=or is <a. $M^1 x = S_1 x - P_1(x-a)$ when x>a.

(4). $M^1 a = S_1 a$.

(5). V_1 = (wind pressure on vertical projection of building and roof × ½ total height) ÷ (span of roof) = [Moment of external wind forces above the center of moments + $S^1{}_2 (l-x) - \frac{1}{2} P_1 (a-x)$] ÷ b, when $x < a$.*

V_1 = [Moment of external wind forces above the center of moments + 2 $S^1{}_2 (l-a)$] ÷ b (when x = a) or = [Moment of external wind forces above the center of moments + 2 $S^1{}_2 l - 2 P_1 a$] ÷ b, when x = zero.

Since 2 $S^1{}_2 l = 2 P_1 a$, the second term reduces to zero leaving only the first, which is the condition when the center of moments is taken at the point of zero bending in the column. This equation is identical with equation (5).

Case II. For columns rigidly fixed at the base and considered as a beam fixed at one end (the base) and supported at the other (the top).

*(6). $M_2 = -\frac{P_2 l}{2}[2k - 3k^2 + k^3]$, or taking moments about base of column we may write in terms of P_2 and $S^1{}_2$.

(6a). $M_2 = -P_2 a + S^1{}_2 l$.

(7.) $M^2 x = -M_2 + S_2 x$ when $x \leq a$. $M^2 x = -M_2 + S_2 x - P_2 (x-a)$ when $x > a$, or in terms of $S^1{}_2$ we may write $M^2 x = S^1{}_2 (l-x)$ when $x \geq a$, and $M^2 x = S^1{}_2 (l-a) - P_2 (a-x)$ when $x < a$.

(8.) $M^2 a = -M_2 + S_2 a$.

*(9.) $S_2 = \frac{P_2}{2}[2k - 3k^2 + k^3] + P_2 (1-k)$.

*(10.) $S^1{}_2 = \frac{P_2}{2}[2k - 3k^2 + k^3] + P_2 k$.

(11). V_2 = [Moment of external wind forces above the center of moments + $2S^1{}_2 (l-x) - 2P_2 (a-x)$] ÷ b, when $x < a$.

V_2 = [Moment of external wind forces above the center of moments + 2 $S^1{}_2 (l-a)$] ÷ b, when x = a.

V_2 = (Moment of external wind forces above the center of moments + 2 $S^1{}_2 l - 2 P_2 a$) ÷ b.

When x = zero, since the first term of the second member of this equation is the same as V_1 (when x = zero) and the second is equal to $-\frac{2M_2}{b}$ we may write:

$$V_2 = V_1 - \frac{2M_2}{b}$$

Process for Case II.—S_2 being known, solve equation (9) for P_2 the load at the foot of knee brace. Substitute value of P_2 in equations (6) and (10) and solve for M_2 and $S^1{}_2$.

The horizontal reaction or shear at the base of the columns is a known quantity; it remains the same whether the columns are hinged or rigidly fixed at the piers. For the two columns of a bent, it is equal to the horizontal component of the wind on one panel of the roof and building. This total shear or reaction is assumed to be equally distributed between the two columns. The wind loads are considered concentrated, and the concentration at the foot of the column is disregarded in the analysis of stresses in trusses and columns, but is considered in the calculation for anchor bolts, masonry, etc.

External Forces.—The columns in deflecting from the wind loads have a leverage action, producing certain horizontal reactions at the foot of the knee braces and at bottom chord of roof truss, which must be considered as external forces, in finding the vertical reactions and in the analysis for stress in the knee braces and roof truss.

Vertical Reactions from Horizontal Forces.—Taking the center of moments at any point in the axis of either column, the vertical reaction at the opposite column, in any case, is equal to the algebraic sum of the moments of all the external forces above this point, divided by the span of the building. The center of moments may be taken at any point in the axis of the column, but the most convenient points are at the base of the column, at the point of contraflexure, and at the foot of the knee brace.

Vertical Reaction from Vertical Forces.—The vertical reaction at either column, resulting from the vertical components of the horizontal wind force, is equal to the sum of the moments of these vertical forces about a point in the axis of the other columns, divided by the span of the building.

For analyses in which only the horizontal compounds of the wind force is dealt with, as in Cases 1 and 2, the vertical reactions resulting from the horizontal component only need be considered. When, however, as in Case 5, the analysis is made for the horizontal and vertical components of the resultant normal wind pressure, the algebraic sum of the the corresponding vertical reactions must be considered. In all cases the wind and dead load stresses have been determined separately for the purpose of comparison and to locate the alternating stresses. To determine the net stresses in the members, and the resultant overturning action in the building, the stresses and reactions for dead and wind loads must be combined algebrically.

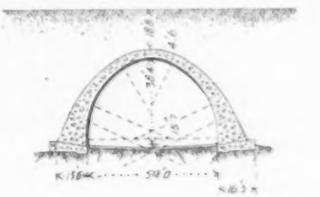
A treatment of the wind stresses in masonry piers for the columns will be added to the Revised Transactions; the stresses in anchored columns due to expansion will also be considered.

The method of analysis for horizontal forces which has been used in this paper for buildings is applicable to through bridges, containing overhead tranverse bracing, and having the floor beams riveted between the posts.

*Valuable tables for the easy solution of equations 6, 9 and 10 will be found in Howe's "Continuous Girders," Engineering News Publishing Co., 1889.

A CONCRETE ARCH OF 59 FT. SPAN.

We reproduce from the "Journal fuer Gasbeleuchtung und Wasserversorgung" the accompanying section of a concrete arch recently completed at Dresden. According to a paper read by Mr. E. Dyckerhoff before the association of German Portland cement manufacturers, this arch was constructed to carry a small river a distance of 146



ft. under the new freight yards at Dresden. The arch is built throughout of well rammed concrete. Its span is 59 ft., clear height 39.7 ft. The height of the embankment on top of the arch is 18.8 ft. The arch has a thickness of 13.6 ft. at skewbacks and about 4.6 ft. at its apex. The arch is founded on rock a short distance below the springing line.

STORAGE BATTERY STREET CARS IN PARIS.

The Northern Tramway Co., of Paris, France, is about to experiment with traction by electric storage batteries. There will be 16 cars of the ordinary type, accommodating 52 passengers each. The body of each car is mounted on two independent axles arranged in separate truck frames. Each axle is fitted with a motor of the Manchester type giving 10,000 watts (about 13½ HP.) when running at 1,200 rev. per min. The E. M. F. varies according to the speed, the maximum being 200 volts. The reduction in the speed is effected in the proportion of ten to one by means of two pairs of wheel gearing, and the efficiency guaranteed between the motor axle and the terminals of the dynamo 70%. The speed of the motor is regulated by a switch having three handles. One of these allows of a change from high to low speed, the reverse operation only being possible by the aid of a key, which is not in the possession of the driver, but is kept at the barrier by an employee who can make the change when the car is to run outside the city limits. The second lever short-circuits one motor at low speed, if, owing to an accident, the use of one of the two must be discontinued. The third lever controls the direction of rotation by the reversal of the current. Each car is fitted with a brake.

The accumulators are contained in six boxes, arranged under the longitudinal seats inside the car. They comprise 108 Laurent-Cely cells, each having twelve plates and about 37½ lbs. of active material, and presenting a side surface of 8 ins. by ¼-in. The boxes are closed by india-rubber plates which prevent spilling of the solution through the jolting of the car. The daily journey of a horse car in Paris is 62 miles, but it is expected that 80 miles will be run by each electric car, thus requiring five tons of cells. Each car will carry 2½ tons of accumulators, and when the half day's work is nearly accomplished the car will return to the station for a new set. The cells are made by the Societe pour le Travail Electrique des Metaux, at Saint-Denis, where they will be charged and transported to the cars on small cars having movable platforms. The charging station will contain four 125 HP. steam engines with horizontal cylinders and Corliss gear, and running at 70 to 160 revs. These engines will drive Desroziers dynamos of 60 kilowatts.

TRANSITION CURVES ON STREET RAILWAY LINES.

We are indebted to Mr. Frank H. Sloan, Chief Engineer of the City & Suburban Ry. Co., of Baltimore, for the accompanying drawings of specimen transition curves used by him in the reconstruction of the street railway system of Baltimore. Transition curves have been used in several instances on street railway lines, but their use is by no means as general as it should be for the profit of the companies and comfort of the passengers. It is not especially important what form of

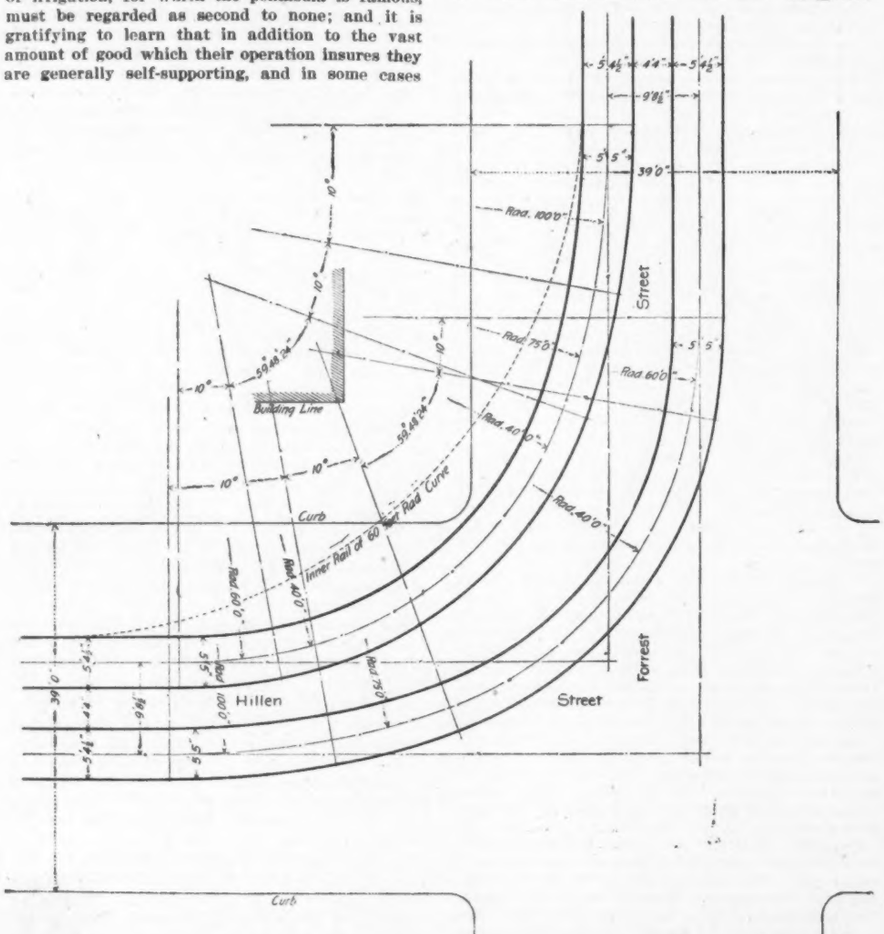
transition curve is adopted, the only essential is that the transition from the tangent to the sharpest degree of curvature shall be made as gradually as possible. Mr. Sloan writes:

I send you two tracings showing plans of a curve especially adapted for street railways in cities where the streets are very narrow. I expect to use these curves in all our future work, comprising 66 miles of track, which we are reconstructing for electricity. On both tracings is shown the inside rail of a simple curve, which would not give nearly as good operating facilities, and yet encroaches on the curb line—a very serious objection, and one which entails additional expense in construction, especially when an electric light pole, gas post or awning occupies the corner. As to the other merits of the curves, I think the tracings will show for themselves.

IRRIGATION CANALS IN INDIA.

A report on the irrigation canal works of India has recently been issued by the government of India, giving some very interesting particulars as to the great value of these works. The "Indian Engineer" says that among the numerous benefits which have resulted from English rule in India, that conferred by the magnificent works of irrigation, for which the peninsula is famous, must be regarded as second to none; and it is gratifying to learn that in addition to the vast amount of good which their operation insures they are generally self-supporting, and in some cases return a fair percentage to the government. The net profit to the state up to the end of the year 1890-91, after paying 4% interest on the capital outlay, amounted to over $12,300,000. The irrigation works are constructed and maintained by the officers of the Irrigation Branch of the Public Works Department. The rapid development of main lines has prevented until lately a very minute attention to details of water distribution, but with the development and introduction of more scientific methods of distribution a higher efficiency may be expected. The year 1890-91 is the first year in which the financial results of Irrigation and Navigation Works throughout the whole of India have been brought together in a comprehensive form.

The works are divided into two main classes, Major and Minor, the former being again subdivided into Productive Works, that are estimated to pay at least 4% within ten years after completion, and Protective Works, which are undertaken to protect certain tracts from famine. Minor Works include a number of improvements to irrigation systems existing before the British government took them over, and agricultural operations such as river embankments. Productive works are constructed with borrowed capital, supplemented by grants from the revenues set aside annually for Famine Protection and Insurance. For Protective Works the capital outlay comes out of the provision for Famine Insurance. The revenue receipts are both direct and indirect. The former comprise the water-rates levied on irrigated lands, the sale of water for sundry purposes and for the supply of towns, receipts from plantations, canal produce, water-power, navigation, etc. Indirect receipts consist of the enhanced land-revenue due to irrigation. In the case of Minor Works no credit is afforded on account of these indirect receipts, which are included in the general land revenue. The canals in India are of two classes: 1, tidal canals, which are for navigation only, and, 2, the larger perennial canals which serve for navigation with irrigation. Perennial canals are, as a rule, provided with head works and weirs to raise the water level in the river and afford a supply at all seasons. They may be sub-divided into deltaic and non-deltaic. In deltaic tracts the bed of the river is little below the level of the surrounding country, and water can be distributed by gravitation without the intervention of any great length of leading canal. Considerable lengths of embankment are necessary in conjunction with these canals, as a protection against flooding from the river. Non-deltaic canals tap the river high up in its course, where the bed is far below the ground surface, and they require to be carried considerable distances before the water can be distributed by gravitation, or even by moderate lift. An inundation canal consists of a channel with an open head, in some cases provided with a regulator, and irrigates the alluvial valley formed by the river. Its supply of water diminishes rapidly as the river falls, so that it sometimes happens there is insufficient supply to bring the irrigated crops to maturity. The most important tanks and reservoirs are in Madras, Bombay and Rajputana. In the Madras presidency alone there are more than 30,000 irrigation tanks, many of these being valleys closed by large masonry dams. There is only one tidal canal of importance, the Hidgellee canal in Bengal, but navigation is combined with irrigation in several others.



TRANSITION CURVES AT CORNER OF HILLEN AND FORREST STREETS, BALTIMORE, MD.

The total length of canals and distributary channels included in the Major Works amounts to 27,532 miles, of which Bengal has 2,969; the Northwest provinces, 9,608; the Punjab, 6,241; Madras, 7,299; and Bombay, 1,420. These provinces are at present by far the best watered, if not the most profitable, territory in India. The smaller channels maintained by the cultivators, often built by the government, and far exceeding those of the government in length, are not taken into consideration. All the works in native states, some of them important, are also omitted in the report.

Great strides have been made during the last five years in irrigation, the area irrigated by Major Works rising steadily from 5,000,000 acres in 1886-87 to 7,000,000 acres in 1890-91, and the gross revenue from $5,400,000 to $7,000,000. The area irrigated by Major and Minor Works during 1890-91, amounted to 9,275,102 acres or 14,492 sq. miles. This is the net area actually irrigated, the gross area covered and commanded by the canals being much more extensive. Considered with respect only to isolated canals or even provinces, a marked increase in irrigation or revenue is not always a reliable criterion of increase of efficiency. It may be due to exceptional and local causes, such as deficient rainfall; but for the whole of India there is a steady annual improvement which is due both to developments in the irrigation works themselves and to economy in working.

In the province of the Punjab inundation canals irrigate the alluvial valleys, and are dependent upon the river floods for their supply. They are mostly built with open heads, and are much troubled with deposits of silt and a short supply of water at unseasonable times. The canals of the Punjab irrigated above 3,000,000 acres in the year 1891-92, and the direct income represented a return of 4.76% upon capital outlay, which must be regarded as highly satisfactory. In this province there are twelve canals in operation, of which five are perennial and seven are inundation canals. The inundation canals did admirable work during the year and irrigated 1,318,717 acres; a considerable sum was expended in extensions and improvements, but these included no works of special importance. The report gives some attention to the work executed in connection with the Chenab canal, in the Punjab, comprising the head regulator, undersluices, weir, excavation and masonry works on feeder line and protective works in the river. The latter consist of an embankment about four miles long, in continuation of the weir extending up to the high ground on the right bank of the river, and of a curved embankment, or bund, from the right abutment extending 5,250 ft. above and 1,000 ft. below the weir, strongly protected with stone on the principle advocated by Mr. J. R. Bell for the protection of railway bridges over the Punjab rivers. Gaps had to be left in the embankment and in the Bell embankments in order to pass the river behind the right abutment pending the completion of the weir. The work progressed steadily, and in February the river was diverted over the weir, the gaps were closed, and by the end of March all the embankments were completed.

The net return from all Productive Irrigation and Navigation Works amounts for the year 1890-91 to 5.8% on the capital outlay. This result includes the figures relating to projects such as the Chenab canal in the Punjab, and other works in Madras, which were in course of construction. Some of the canals yield quite extraordinary results. The Cauvery Delta system yields 40%; the Eastern Jumna canal, 24%; while others yield profits varying from 7 to 15%. If the Protective

Works are also taken into consideration, the net profits are reduced to 4.52%. These taken alone return only 0.79%; but the policy which dictated these works, the outcome of the Famine Commission, 1880, did not contemplate a productive expenditure upon them. The economic importance of the irrigation works to the country is, however, far greater than might be inferred from the above figures, for the estimated value of the crops grown under irrigation in 1890-91 amounts to $9 per acre, and is nearly equal to the whole of the direct capital outlay incurred on the works up to date. The principal crop watered by the canals is rice, the area being double that of the wheat irrigated.

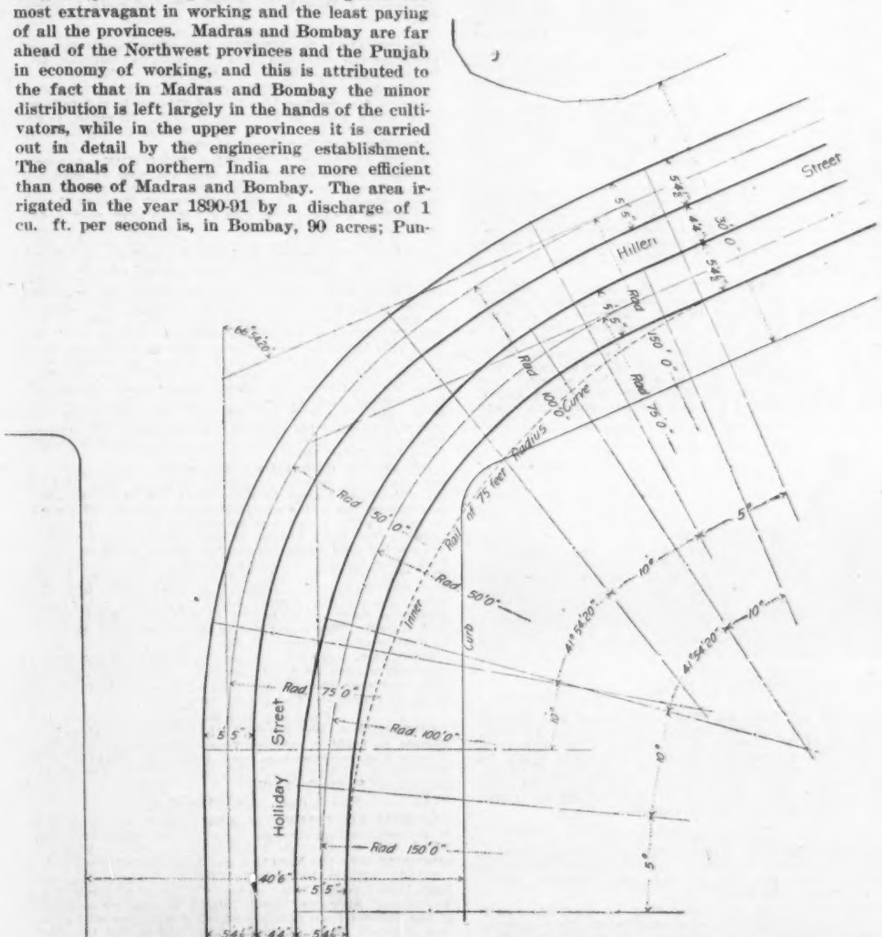
The following figures illustrate the comparative efficiency of the different provinces. The total cost of working is, in Madras and Bombay, 26 cts. per acre irrigated, in the Punjab 36 cts, in the Northwest Provinces 46 cts., and in Bengal 82.5 cts. per acre. The net profits paid in 1890-91 are: Bombay (Sind), 7.5%; Madras, 7.0%; Punjab, 6.3%; Northwest Provinces, 5.4%; Bombay (Deccan), 1.1%, and Bengal nil. Thus Bengal is the most extravagant in working and the least paying of all the provinces. Madras and Bombay are far ahead of the Northwest provinces and the Punjab in economy of working, and this is attributed to the fact that in Madras and Bombay the minor distribution is left largely in the hands of the cultivators, while in the upper provinces it is carried out in detail by the engineering establishment. The canals of northern India are more efficient than those of Madras and Bombay. The area irrigated in the year 1890-91 by a discharge of 1 cu. ft. per second is, in Bombay, 90 acres; Punjab, 189; Bengal, 96; Madras, 111; Northwest provinces, 204 acres. The results exhibit wide divergences, which are attributed in part to inaccurate observation of canal discharges, but this is a fault which can be remedied. The question of duty, or the proportion which the area irrigated bears to the volume of water used, is one of primary importance. Of late years very great attention has been paid to the gaging of channels and measurement of the discharges in the Punjab and the Northwest provinces, and the results for the year 1890-91 appear to show that a very fair standard of accuracy has been attained equal to the whole of the direct capital outlay incurred up to date. The total area of crops irrigated in 1890-91 amounted to 8,113,468 acres, and the area of principal crops irrigated were as follows:

Crop.	Acres.	Crop.	Acres.
Rice	3,947,401	Cotton	429,655
Wheat	1,955,294	Sugar cane	300,743
Millet	572,864	Indigo	224,663
Bajra	506,092	Barley	116,696

The accompanying table shows the comparative efficiency of the different provinces as regards economy of water, by a comparison of the duty obtained from a unit of discharge; the unit being one cu. ft. of water expended per second:

Province.	Area irrigated. Hot Season. Acres.	Cold Season. Acres.	Total. Acres.
Northwest	81	123	204
Punjab	65	124	189
Madras	100	11	111
Bengal	76	20	96
Bombay	54	36	90
Sind	41	...	41

The high cold weather duty obtained in the Northwest provinces and the Punjab is due partly to the constant snow-fed character of the rivers and partly to the fact that the crops require fewer waterings in the cold than in the hot season. The comparatively large hot weather duty obtained in Madras is due to the irrigation being, to a great extent, rice watered during the monsoon, the canal water being supplemented by the rainfall.



TRANSITION CURVES AT CORNER OF HILLEN AND HOLLIDAY STREETS, BALTIMORE, MD.

The discharge of all the main canals of the Northwest provinces amounts in the aggregate to over 15,000 cu. ft. per second, so that an increase of duty of 10 acres would represent an annual increase of area irrigated by 50,000 acres, or an increase of $17,000 in revenue. It is not, however, advisable to push economy of water to an undue extent, as to lead to insufficient watering and the introduction of inferior crops requiring less water. Highly cultivated, well-manured land, requires plenty of water, and the decision of the volume to be allotted is one about which there must be a certain amount of elasticity, and which can only be made according to the circumstances of the case. The Northwest provinces may, on the whole, be well satisfied with the position they hold. Greater progress is just now being made in the Punjab, but there it is more urgently needed.

A considerable length of the canals is navigable. In Madras, 1,232 miles; Bengal, 641; Northwest provinces, 535; Punjab, 432; or in all 2,840 miles. But the navigation is only of secondary importance, and only on the Calcutta and Eastern canals do the revenue receipts exceed the working expenses. As a whole, the navigation works pay about 8% on the capital outlay. The navigation is of indirect value in developing the plantations and carrying materials for canal works. The rapid current necessitated by the irrigating requirements of the canals and the silt-laden character of the water militate strongly against the use of these canals as a means of transport. Eight to sixteen trackers are required to tow each boat up stream, while only a few of the men are wanted for the return journey. The occupation of tracking is not a favorite one with coolies, who are sometimes decoyed to the boats under false pretenses, and turned adrift when the journey's end is reached. Some special efforts are required to place the navigation of the canals on a sounder financial basis and to regulate and encourage the passenger traffic, which, for the Punjab and Northwest provinces, as shown in the returns, is quite insignificant.

ELECTRIC WELDING IN CARRIAGE MANUFACTORIES.

At the convention of the National Association of Carriage Builders, held at Buffalo, N. Y., last week, a paper was read by Mr. F. P. Royce, of the Thomson Electric Welding Co., giving some interesting particulars of the application of electric welding in carriage manufacture. Comparing the cost of electric and forge welding, he said that the attendance of the dynamo generally causes no additional expense, as the engineer can look after it in addition to his regular duties, with little trouble. All it requires is proper oiling and keeping the brushes and collector rings clean. The principal cost of welding, therefore, is the labor required at the machine and the cost of the power. With light work and pieces of regular shape, one man only is needed to operate the welder. Where great rapidity is essential a boy helper to bring and carry away stock is advisable. In axle works two men, one doing the welding and the other reducing the burr or upset under the hammer and setting the axle, can turn out 150 sets of 1-in. axles or 100 sets of 1½-in. axles per day.

With light iron buggy tires one man with a boy helper to handle stock, can weld 700 to 800 daily, or 400 to 500 steel tires. The removal of the upset or burr at the weld is an important element in the cost of welding. Hammering is the cheapest and best method thus far tried. It not only reduces the upset to the proper size but strengthens the weld.

In the first use of electric welding the perparation of the surfaces to be joined was quite an item of expense; but it was soon found more economical to increase somewhat the strength of the current and join the metal without cleaning or preparation. This applies, however, only to the ordinary oxide or mill scale. A thick coating of red oxide or dirt should of course be cleaned off before welding.

The horse-power absorbed by the current while in actual use in welding, is about as follows:

Axle Welding. Size.	HP. required.	Time required. seconds.	Tire Welding. Size.	HP. required.	Time required. seconds.
1 in. round.	25	45	1 × ⅞	11	15
1 in. square.	30	48	1¼ × ¾	23	25
1¼ in. round.	35	60	1¼ × ⅞	20	30
1¼ in. square	40	70	1¼ × 1	23	40
2 in. round.	75	95	2 × ¼	29	55
2 in. square.	90	100	2 × ¾	42	62

Besides tires and axles, T-joints, fifth-wheels, step-irons, rails and many other parts of carriages are successfully welded by electricity. To meet the needs of small manufacturers whose output is not sufficient to warrant the expense of an electric welding plant, but who have work which could

advantageously be done by electricity, the Thomson Electric Welding Co. proposes to establish jobbing plants in different cities, equipped with machines of various capacities, of the "Universal" type.

ENGINEERING SCHOOLS IN INDIA.

In our issue of Aug. 4 we gave some particulars of the four official engineering schools in India, and at the same time illustrated the College of Engineering, Madras.

The Thomason Civil Engineering College, Roorkee, which we illustrate this week, is the largest and most important engineering college in India, according to a brief article in "Indian Engineering." The style of the building is of a much less ornate character than that of the Madras College, which is designed more in the Byzantine style of architecture seen so frequently in the great buildings of India, while the Roorkee College is of a more severe and classic style. This college was established in 1847 under the auspices of Hon. James Thomason, Lieutenant-Governor of the Northwest Provinces, and, according to the original scheme, was "designed to give theoretical and practical instruction in civil engineering to Europeans and natives, with a view to their employment on the public works of the country, according to their several qualifications and the requirements of the service." In 1854 it was considered that "an institution of such peculiar importance to India, and of a character so entirely novel in the country, should bear the name of its founder," and accordingly thenceforth it received its present designation. In the words of Sir Auckland Colvin, "the college has most entirely fulfilled, so far, the purposes for which it was intended. It has acquired for itself a very considerable name; and there have passed through its ranks many men who have achieved eminence in the Public Works of India."

The following are some of the prizes given at this institute: the Thomason gold medal, for the student who furnishes the best engineering design of the year, over a certain minimum excellence.

THOMASON CIVIL ENGINEERING COLLEGE; ROORKEE, INDIA.

The Cautley gold medal, for the best mathematician in the college, who shall obtain not less than two-thirds of the total number of marks in that subject. The Maclagan prize of books, for excellence in physical science. The Keay memorial silver medal, for the best estimator in the upper subordinate class. Rai Bahadur Kanhaya Lal's gold medal, for the best native student of the year who fails to obtain the Thomason prize, and silver medals for the best native students in the upper and lower subordinate classes respectively. The Cautley and Thomason silver medals, for the best mathematician in the upper subordinate class, and for the student who shows most proficiency in civil engineering in the said class, respectively. In addition to these are two money prizes: the Council of India prize of $333 for the most distinguished student, and the Thomason prize of $85 for the most distinguished native student. There are also college and other prizes.

The Torrence elevated terminal railway project for Chicago is now ready to commence construction, the action of the directors of the Atchison, Topeka & Santa Fe Ry. in selling the right of way and property in Chicago having been ratified by the stockholders. The project was described in our issues of Jan. 2 and May 5.

A waterway between the Baltic and the Black Sea, says the London "Chronicle," is under discussion in Austria. The plan proposed is a canal connecting the Oder and the Danube rivers, and a French syndicate is said to be surveying the route. Judging from the map of Europe, the canal would be a long one and would have some ugly mountains to cross.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

KAATERSKILL.—It is reported that this company will extend its line from Kaaterskill Station to the upper terminus of the Otis Elevating Ry., near the old Catskill Mountain House. It is said that the right of way has been secured and that the line will be ready for use next season. The road will be 3 ft. gage.

PENNSYLVANIA.—The city of Allegheny, Pa., is negotiating with this company for the construction of a system of elevated railways. It is proposed to divide the work into three divisions: (1) from the Allegheny River to Marshall St.; (2) from Marshall St. to Washington Ave.; (3) from Washington Ave. to the north line of the city. The plans and estimates for the first division have been completed. It is estimated to cost $850,000. The whole line will cost about $2,000,000.

OHIO SOUTHERN.—At a recent meeting of the stockholders it was voted to build the proposed extension from Springfield to Lima, O. Work is to be begun at once and the line completed by March 1.

BANGOR & AROOSTOOK.—About 45 miles of this line have been graded south of Houlton, Me. No track has yet been laid. Ch. Engr., Moses Burpee, Houlton, Me.

BEECH CREEK.—The grading has been completed on the 36-mile extension, from Kerrmoore to La Jose, Pa., and it is expected to have the track laid by Dec. 1. The extension is stated by a local paper to have cost $1,000,000, the heavy cost being largely owing to the construction of two tunnels near La Jose. It is also announced that the contracts be let for a further extension to Kayler, Pa.

PEMIGEWASSET VALLEY.—An extension 1¼ miles long will be built this autumn to accommodate the lumber business.

PHILADELPHIA & READING.—At a recent meeting the stockholders of the Philadelphia & West Chester R. R. Co., decided to increase its capital stock $50,000, and to commence the construction of its line from Exton to West Chester, Pa., 6 miles, as soon as possible.

PHILADELPHIA & READING.—The short extension from Harvey's Lake to Noxen, Pa., has been completed.—The efforts being made to build the Philadelphia & Cape May R. R., to be operated by this company, are taking definite shape. Among the principal promotors are: John C. Bullett and Thos. Robb, of Philadelphia, Pa.

TOBIQUE VALLEY.—Thos. P. Connor, St. John, N. B., writes us that a force of 350 men are now at work on this New Brunswick railway, between Perth Center and Plaster Rock. The total projected length of the line is 80 miles, and it is to run from Perth Center, N. B., on the Canadian Pacific Ry. to Dalhousie, N. B., on the Inter-Colonial Ry. On the 28 miles from Perth Center to Plaster Creek, about 20 miles of track have been laid, of which six miles were laid since Jan. 1, 1892. It is expected to have the remaining four miles completed by Dec. 15. The contractors are Lawlor, Conner & Co., and the engineer in charge of the work is Frank D. P. Lawlor. The object of the line is to develop the timber and plaster rock lands along its route. The company has subsidies of $3,200 and $2,500, respectively, from the Dominion and New Brunswick governments. The line will be operated by the Canadian Pacific Ry. Co., when completed.

Projects and Surveys.

OLEAN, OSWAYO & EASTERN.—Chartered in Pennsylvania to build a railway from Genessee Forks to Oswayo, Potter Co., Pa. Capital stock, $200,000. Pres., J. B. Rumsey, Columbus, O.

ONTARIO.—It is announced that an application will be made at the next Canadian Parliament for a charter to build a railway from Pemberton to Haliburton, Ont., 80 miles.

ANNAPOLIS & ATLANTIC.—Pres. Robt. G. Hervey, 15 Wall St., New York City, writes us that this company was chartered April 16, 1888, and proposes to build a railway from Sand Point, N. S., to Halifax, N. S., 150 miles, with branches. Surveys were begun at Sand Point, Shelburne Harbor, Oct. 1, 1892, and will be completed to a connection with the Nova Scotia Central Ry., at New Germany, N. S., 74 miles, by Dec. 10. Between Sand Point and New Germany the route passes through Shelburne, Dunraven Lodge, Indian Garden, Cameron's Landing, Caledonia, Brookfield and Pleasant River. There will be no bridges over 150 ft. long. About 65 miles of the right of way has been obtained. The principal business will be in lumber, supplies to the gold mines and the tourist traffic. The company has a subsidy of $3,200 from the Dominion Government and the same amount from the Nova Scotia Government. It is expected the first division from Sand Point to New Germany, will be completed in 1893.

COBOURG, NORTHUMBERLAND & PACIFIC.—Bids will be received until Nov. 15 for the construction of this railway from Cobourg, Ont., to Central Ontario Junction, Ont., 48 miles. Ch. Engr., H. K. Wicksteed, Cobourg, Ont.

ILLINOIS, INDIANA & MICHIGAN.—It is announced that the contract for building this proposed railway from New Buffalo to Hammond, Ind., about 45 miles,

Southern.—Existing Roads.

EGYPT.—It is stated that work has been begun upon an extension of this railway from Egypt, N. C., toward Asheboro, N. C. The road now runs from Colon, N. C., to Egypt, 8 miles.

JACKSONVILLE, ST. AUGUSTINE & HALIFAX RIVER.—Efforts are being made to secure a further extension of this railway from Rock Ledge to Eau Gallie, Fla., about 15 miles.

Projects and Surveys.

GEORGIA, TENNESEE & ILLINOIS.—Arrangements are now being made for the construction of this proposed railway from Tallapoosa, Ga., to Stevenson, Ala., 125 miles. The surveys have been made and contracts for construction will be let at an early date. Gen. Man., S. I. Wheatcroft; Ch. Engr., L. F. Bellinger; both of Tallapoosa, Ala.

CHATTAHOOCHEE VALLEY.—This company has filed with the Secretary of State of Georgia a petition to build a railway from West Point, Ga., to Eufaula, Ala. Among the incorporators are: W. C. Lanier, and A. S. Freeman, of West Point, Ga.

PENSACOLA, ALABAMA & TENNESSEE.—A railway company by this name has been chartered in Florida. It is stated that it is the new name for the Pensacola Northern R. R. Co., recently reported as to be chartered by Henry McLaughlin, of St. Louis, Mo.; C. H. Dishman, L. Hilton Greene and others, to build a road north from Pensacola to an Alabama connection, and the name was changed owing to its similarity to the Pensacola Northwestern. The line is to be 40 miles long, 9 miles of which will likely be made up by using the Pensacola & Perdido R. R. The capital stock is $100,000.

Northwest.—Existing Roads.

CENTRALIA & CHESTER.—Grading has been completed on the extension from Nashville to Centralia, Ill., 22 miles, and tracklaying is being rapidly pushed.

SIOUX FALLS, YANKTOWN & KEARNEY.—The contract for grading 14 miles of this projected railway from Sioux Falls to Yankton, S. Dak., 62 miles, is reported let to M. O'Neil, of Yankton, S. Dak. It is stated that work is to begin at once.

PORT ARTHUR, DULUTH & WESTERN.—A correspondent writes us that 600 men are now at work on this railway. It runs from Port Arthur, Ont., to the International line, at the narrows of Gunflint Lake, 86¾ miles, with an extension six miles long, now under construction, into Minnesota. Tracklaying and ballasting on the main line are now finished to the 81st mile from Port Arthur, and will be entirely completed by Nov. 30. The maximum grade going east is 60 ft. per mile, and going west, 95 ft. per mile. The maximum curve is 9°. The company has a subsidy of $6,200 per mile from the Canadian government, and bonuses of $26,000 and $15,000, respectively, from Port Arthur and Ft. William, Ont. The principal business of the road will be in silver and iron ores, and lumber. The contractors for the line were Middleton & Conner, Port Arthur, Ont., and the engineer in charge of the work was R. A. Hazlewood, Port Arthur, Ont. It is the intention of the company to continue the line west to a connection with the Duluth & Iron Range R. R., and also to build the Ontario & Rainy River Ry. to Lake of the Woods, connecting there with a railway south from Winnipeg, Man.

ST. LOUIS, CHICAGO & ST. PAUL.—This company now has two extensions under contract. The first of these is from Laomi to Springfield, Ill., 14 miles, the contractors for which are Podesky & Lyman. The work is light, with maximum grades of 40 ft. per mile. Seven miles from Lavini to one mile north of Curran are graded, and about one-half a mile of track has been laid. The second extension is from Alton to Kinder, Ill., 15½ miles, for which the contractors are B. T. Johnston & Co. The grades are easy, and about 2½ miles are on the bottom lands along the river, and require a 10-ft. embankment to bring the track above high water. The construction work on both lines is in charge of Ch. Engr. E. M. Rice.

MIDLAND PACIFIC.—A Pierre, S. Dak., paper states that $25,000,000 of bonds of this company have been sold, and that the construction of the line from Sioux Falls to Pierre, S. Dak., will soon begin.

Projects and Surveys.

CHICAGO & SOUTHERN ILLINOIS.—Chartered in Illinois to build a railway from Chicago to Pana, Ill. Among the incorporators are Frank E. Hinkley, and William F. Holcomb, of Chicago, Ill., and Frank H. Jerome, of Springfield, Ill.

Southwest.—Existing Roads.

NORTH LOUISIANA & ARKANSAS.—Grading has been completed on the line from Bastrop to Collins, La., which this company is building in pursuance with its agreement with the New Orleans & Northwestern R. R.

GULF, NEWPORT & NORTHERN.—A press dispatch from Port Lavaca, Tex., says: "Work on the new railway from Alligator Head inland is moving rapidly. It has not yet been decided whether the road will go to San Antonio or to Victoria. The survey for the first 20 miles is already completed and more than one mile has been graded. The grading force is at work constantly and is being daily augmented. Supplies are being brought in from Galveston by boats."

TEXAS & SABINE VALLEY.—It is stated that this Texas railway noted last week will build two miles of its proposed line this year.

Rocky Mt. and Pacific.—Existing Roads.

MARICOPA & PHOENIX.—The Phoenix, Ariz., papers state that a short branch will be built from Tempe, Ariz., to Mesa City, Ariz.

BURRARD INLET & FRASER VALLEY.—Pres., C. D. Rand, Vancouver, B. C., writes us that this company was chartered in April, 1891, in the interest of the Northern Pacific R. R. Co. It proposes to build a railway from Sumas, Wash., via Langley to Vancouver, B. C., 47 miles. The preliminary surveys have been completed and nearly all of the right of way secured. The work will be easy. There will be a 1,600-ft. bridge across the Fraser River. It is expected to let the contracts for construction in December, 1892, and to have the line completed one year later. The city of Vancouver, B. C., has voted $300,000 of 4% bonds in aid of the road.

BUTTE, ANACONDA & PACIFIC.—About 225 teams are now at work on this line from Butte to Anaconda, Mont. Four miles of grading have been completed.

ATCHISON, TOPEKA & SANTA FE.—A dispatch from Deming, N. Mex., states that this company pro-

poses to build a branch from Deming, N. Mex., to Benson, Ariz., 130 miles.

SOUTHERN PACIFIC.—The contract for the 16 miles of the proposed Santa Margarita-Ellwood line, from Santa Margarita to San Luis Obispo, Cal., has been let to George Stone & Co., of San Francisco, Cal. This work is estimated to cost $1,500,000. There will be about 8,000 ft. of tunnelling on seven tunnels. The longest of these will be 3,700 ft.

Projects and Surveys.

ALBANY & ASTORIA.—Ch. Engr., W. B. Barr, Albany, Ore., writes that a preliminary survey has been made for this line from Albany, Ore., via Independence, Dallas, Sheriden, Grand Ronde, Dolph, Tillamook, Nahalem and Seaside, to Astoria, Ore., 103 miles. Maximum grade ½% and maximum curve 10°. There will be two large bridges and two tunnels.

SIUSLAW & EASTERN RY. & NAVIGATION CO.—Gen. Man., Isaac Britton, Eugene, Ore., writes us that this company was chartered in 1889 and reorganized in 1891. It proposes to build a line from Siuslaw Harbor, Ore., via Florence, Scaton, Walton, Almira, Eugene, Painesville, Jordan Valley, Silver City and Albion, 754 miles. The line has been located from Siuslaw Harbor to Eugene, 80 miles, and preliminary surveys have been completed as far as Painesville, Ore. The maximum curve is 6° and the grades are for the 1st division, 52 ft. per mile; 2d division over the Cascade Mts., 75 ft. per mile; 3d division, 52 ft. per mile. There will be one tunnel 2,200 ft. long and seven spans of bridging, each 200 ft. long. The right of way for the 1st division has been secured and local aid to the amount of about $110,000 besides extensive land grants obtained. The road is to be finished in 1894, and work is expected to begin early this year. Its principal business will be in lumber, coal and general merchandise. Vice-Pres., A. G. Hovey, Ch. Engr., T. R. Bury; both of Eugene, Ore.

COLORADO & NORTHEASTERN.—Ch. Engr., H. R. Holbrook, Pueblo, Colo., writes us that this railway is projected to run from Pueblo, Colo., east along the south side of the Arkansas River to Rocky Ford, and thence northeast to Kit Carson and the Colorado line. About 120 miles have been located. Maximum grade, east 15.84 ft. per mile, west 31.68 ft. per mile. Pres., O. H. P. Baxter.

SAN FRANCISCO & SALT LAKE.—The surveys which have been in progress for some time for this proposed railway from San Francisco to Salt Lake City have been completed from San Francisco to the Nevada line and will be discontinued for the winter. The work has been in charge of Ch. Engr., W. H. Kennedy, and a very favorable line is said to have been secured. This company was organized some months ago by San Francisco business men to secure a competing line to the Central Pacific.

Foreign.

MEXICAN INTERNATIONAL.—An official of this company writes us that 164 miles of track had been laid by this company between Jan. 1 and Oct. 1, 1892. This was on the line from Torreon to Durango, 158 miles, and the branch from Pedricena to Valardena, 6 miles. The line from Mondova toward the Sierra Mojada, 135 miles, was stated to be under construction. From other sources we learn that work on this last line is making rapid progress. About 22 miles out from Mondova are now graded and 200 teams are at work. It was expected to begin tracklaying on Nov. 1.

MEXICO.—In his recent annual message to Congress, President Diaz said: "The railway system of Mexico now measures over 10,600 kilos., and the increase since April has exceeded 300 kilos. A large part of this increase is to be credited to the Mexican Southern Ry., which at present only lacks a little more than 40 kilos. to reach Oaxaca, a point to which the line in question will undoubtedly be completed before the end of the year. The International has made even better progress and is rapidly approaching Durango. The Hidalgo Ry. is also progressing, the grading having been completed as far as Tulancingo. The Lower California Ry. has built 17 kilos., making 27 in all. Construction work on the Tehuantepec Isthmus railway has been carried on without interruption, and there is every reason to hope that it will be completed within the term of 15 months agreed on in the contract."

BRITISH MEXICAN.—About 30 miles of the grading have been completed on this railway from Jiminey to the Sierra Mojada, and the rails have been purchased.

INTEROCEANIC.—It is announced that the money necessary to build the proposed line of this Mexican railway from Pueblo to Acapulco, Mexico, has been secured.

ELECTRIC RAILWAYS.

DANBURY, CONN.—Mr. J. K. Wilkes, City Engineer, states it is probable that in the near future the motive power on the six miles of the Danbury & Bethel Horse Ry. will be electricity.

ELIZABETH, N. J.—A company is being organized to build an electric railway to Westfield, 7 miles, and eventually to Plainfield, 12 miles. The company is being promoted by local parties and will have a capital stock of $100,000.

PHILADELPHIA, PA.—The Common Council has passed bills allowing both the Elmwood & Fairmount Park Passenger Ry. Co. and the Fairmount Park & Haddington Co., to use the trolley system in the 27th and 34th wards. The bills include amendments putting restrictions on both companies and placing it in the power of Councils to demand the removal of the poles and wires and the introduction of either the storage or underground system. The right of transfer of privileges is prohibited and provision made for the proper paving and maintenance of streets and avenues. Any interference with any elevated railway that may be built is prohibited. The work on the railway and system must be begun within six months and completed and in operation within a year. The bills as passed are said to be restricted more advantageously to the city than any previously introduced and at the same time feasible for operation by companies.

PUNXSUTAWNEY, PA.—It is proposed to extend the electric road to Clayville as far as Indiana, Pa., a distance of 30 miles.

BALTIMORE, MD.—The Baltimore Traction Co. has acquired control of the City & Suburban Ry. Co.'s system, paying, it is said, about $1,500,000. The transfer involves 65 miles of line, now being equipped for electric traction. The latter company had recently secured a site for a large brick central power station, the cost of which, including machinery, was estimated at $500,000, and it is said the Traction company will carry out the work. The work of erecting the plant will begin as soon as the contracts are awarded. The bids for the machinery are now in the hands of the engineers. The ultimate capacity of the power-house is designed to be 5,000 or 6,000 HP., but the entire machinery for this capacity will not be put in immediately. It is the intention of the engineers to have machinery of 2,500 HP. capacity in working order for the operation of the York Road and Highlandtown lines of the City & Suburban system, which are expected to be ready for electrical operation by February. Compound condensing engines will be used, of 400 to 700 HP. each, and water-tube boilers will be used, arranged in batteries of 500 HP. each. The generators will be of 400 HP. each, and coupled directly to the engines, thus avoiding shafting and counter shafting. The boiler room will be on the street level to facilitate the handling of the coal supply, which will be brought in scows alongside the power station. From the boiler room to the water edge two railway tracks will be built for running the coal into the house. The railways will be arranged either to run to and from the coal scows by gravitation or will be operated by an engine and pulley. The engine room will be built above the boilers to give room for the condensers and pumps under the floor.

WASHINGTON, D. C.—The Washington & Arlington electric road has been completed. It is nearly three miles in length. Heavy work was required to make a good road. The cars are equipped with 40-HP. motors. The road was constructed under the management and direction of Mr. Malone Wheless, and the work was done by the Woodbridge & Turner Engineering Co., of New York.—The Petworth, Brightwood & Tacoma electric road is expected to be in running order by December. Seven passenger cars and one freight car have been ordered, and will be ready when the road is finished.

NASHVILLE, TENN.—The East Nashville Electric Ry. Co. has applied for a franchise and is ready to begin work. Pres., F. W. Hunter.

ATLANTA, GA.—The Atlanta & East Lake Electric Ry. is to be operated by storage battery cars, according to report.

PIQUA, O.—The Miami Valley Ry. Co. has been incorporated by W. P. Orr, W. F. Steiner and W. D. Jones, with a capital stock of $10,000, to build an electric railway to Troy, O.

ST. PAUL, MINN.—The Assembly Committee on Streets has reported favorably the ordinances directing the street railway company to build a horse car line from Como Ave. and Front St. toward Como Park for the distance of a mile, and an electric road from Charles and Rice Sts., to Minnehaha.

OMAHA, NEB.—The franchise of the Metropolitan Street Ry. Co. has been sold to J. E. Markel, of Omaha, representing eastern capitalists. Nothing will be done at present toward improving or extending the line, but it is expected that in the spring work will be commenced on a line along the streets covered by the franchise and that power-houses will be erected. The franchise purchased is in South Omaha, and as yet the company has no way of getting into Omaha, but an effort will be made to obtain an Omaha franchise.

ELEVATED RAILWAY.

BALTIMORE, MD.—The Lake Roland elevated electric railway will be completed by next spring. The elevated railway is 4,100 ft. long, and the entire electric railway 11 miles long. There will be about 3,700 ft. of continuous double track viaduct with lattice girder spans of 40 to 60 ft.,and two pin-connected through spans of 200 and 150 ft. The work also includes the Quarry viaduct, consisting of three spans of riveted lattice trusses, each 130 ft. long. The total weight of ironwork, including roofs, is 3,400,000 lbs., of which the elevated structure proper, 2,700,000 lbs., has been let to the Pennsylvania Steel Co., while the Variety Iron Works have the contract for the Quarry viaduct and for the beams and roof trusses of the power and car houses.

HORSE AND MOTOR RAILWAYS.

SCRANTON, PA.—The Valley Passenger Ry. Co. has been organized to build a line 25 miles long from Archibald to Scranton, Avoca and Hughestown; capital stock $200,000, with $60,000 paid up. Pres., August Robinson, Scranton.—The Hyde Park Ry. Co. has been organized to build a line from Scranton to Hyde Park and Taylorville; capital stock, $50,000, with $10,000 paid in; Pres., John P. Ilsley, Philadelphia.

HIGHWAYS.

CONNECTICUT.—The County Commissioners of Hartford Co., at Hartford, have been petitioned to rebuild three miles of the road from South Windsor to Ellington.

WATER-WORKS.

New England.

WESTBORO, MASS.—Surveys looking to an increased supply and improvements to the filtration plant are said to be in progress under the direction of the water commissioners.

Middle.

WEST ORANGE, N. J.—The West Orange Water Co. has been incorporated to operate under a franchise already granted.

BELLEVUE, PA.—The Borough Council has granted a franchise to the Bellevue Water Co.

COATESVILLE, PA.—Engrs. Hughes & Albright, have been making preliminary examinations for a new supply. Wm. H. Gibson, Pres. Bd. Trade.

MAHANOY CITY, PA.—Borough works are favorably discussed.

PITTSBURG, PA.—Smoke consumers will soon be advertised for.

FROSTBURG, MD.—It is reported that the purchase of the Frostburg Water Co.'s works is under consideration by the Council.

Southern.

POCAHONTAS, VA.—Works may be built by the Pocahontas Water-Works Co., now being organized.

RICHMOND, VA.—It is reported that Sup't. C. E. Bolling has recommended that a 20,000,000-gallon additional pumping capacity be secured, a 48-in. main be laid from the reservoir to the city, and the canals to be enlarged.

ATHENS, GA.—The water bonds have been sold by the city at par. The Rensselaer Valve Mfg. Co., of Troy, N. Y., through Special Agent O. Jones, Chicago, has secured the contract for the valves, and R. D. Wood & Co., of Philadelphia, will furnish hydrants. As stated last week Howard Neeley, Chattanooga, Tenn., is contractor.

LA GRANGE, GA.—H. B. Hodge, E. F. Partridge, J. W. Hawley, and others propose to organize the La Grange Water-Works Co.; $60,000.

KEY WEST, FLA.—It is reported that $100,000 works, with an artesian supply, will be built. W. B. Whalter, Chn. Bd. Cy. Comrs.

HUNTSVILLE, ALA.—Nov. 15 bids for a stand-pipe will be received by the city. Address W. T. Hutchins.

LAWRENCEBURG, KY.—This town has decided to build works by a vote of 3 to 1, it is reported.

North Central.

CLEVELAND, O.—Dir. of Pub. Wks. Herrick, has been instructed to advertise for smoke consumers for three boilers.

SANDUSKY, O.—The city officials are investigating filters.

WAPAKONETA, O.—Nov. 8 the people vote on issuing $65,000 of bonds for works.

EVANSTON, IND.—A general reconstruction of the works is proposed, and Consult. Engr. John A. Cole has recently reported to the city.

LIGONIER, PA.—Dr. McGowan and Engr. Chas. Fogg have been making an inspection of sources of water supply, it is said, with an idea of supplying this place.

ITHACA, MICH.—The proposed new works are estimated to cost $22,000. There will be a stand-pipe.

NAPERVILLE, ILL.—Consult. Engr. John A. Cole, Chicago, has submitted plans for work to be built in the spring. There will be 8 miles of mains, and a 16 × 100-ft. stand-pipe.

Northwestern.

SIOUX CITY, IA.—The Morning Side Electric Light, Heating & Water-Works Co. has applied for a franchise to supply light, heat and water in East Sioux City.

NIOBRARA, NEB.—Engr. Johnson, Sioux City, Ia., has made plans for $5,000 works. The supply will be from artesian wells, already sunk.

Southwestern.

ST. CHARLES, MO.—John A. Cole, Consult. Engr., has been engaged to report on proposed improvements.

SEDALIA, MO.—The Tebo Water, Light & Power Co. has been incorporated; $30,000: M. L. Andrews, S. F. Rosse, D. E. Kennedy. It is said that the company owns a large reservoir, built last summer, about eight miles southeast of the city, for a reserve supply.

Pacific.

HOOD RIVER, ORE.—The Hood River Water Co. has been incorporated to furnish water for irrigating and domestic purposes; $20,000. There is a small private plant here.

PORT TOWNSEND, WASH.—The Council has approved a contract with the Olympus Water Co., probably for the new gravity supply recently mentioned.

CAMPBELL, CAL.—Definite steps toward forming a water company are being taken.

TACOMA, WASH.—Engr. Rudolph Hering, New York, has reported upon works for the city. A purchase and extension of the company's works is recommended, the estimated cost being about $1,800,000. Three other plans are discussed, all as outlined at length in this issue.

ARTESIAN WELLS.

LOWELL, MASS.—Cy. Engr. Bowers has been instructed to make a report, and estimate on the cost of a driven well plant for the city water-works.

NORWICH, CONN.—The Water Commissioners think of having artesian wells sunk, and have been conferring with A. G. Brown, Hartford.

IRRIGATION.

SAN DIEGO, CAL.—A press dispatch states that the ranchers of Highland mesa have organized the Highland Irrigation & Pumping Co., to bring water from the bed of the Otay River, and that work will begin at once on a two-million gallon reservoir and a pipe system to cost $125,500.

NEW COMPANIES.—Shoshone Falls Electric Power & Irrigation Co., Chicago, Ill.; $25,000,000: developing water for irrigation, power and light. North Fork Canal & Reservoir Co., Great Falls, Mont.; $50,000: J. K. Clark, H. L. McIntyre and D. R. Thornber: water will be taken from the North Fork of Milk River.

SEWERS.

PORTLAND, ME.—We are informed by E. C. Jordan, Cy. Engr., that Ilsley & Cummings of this city are engineers for the proposed system of sewers at Deering, noted in our issue of Oct. 27.

SANFORD, ME.—It is proposed to organize a stock company for the purpose of building a system of sewers.

BOSTON, MASS.—The Board of Health is considering the drainage of the north side of Beacon St., between Otter and Hereford Sts. Plans have been prepared for two sewers for this district, to cost about $80,000 and a narrow embankment in the Charles River, which the City Engineer says can be constructed for $50 per lin. ft.

BROOKLINE, MASS.—At a special town meeting Oct. 31 the citizens appropriated $17,000 for sewers.

LYNN, MASS.—The Council has ordered the construction of sewers in four streets.

WOBURN, MASS.—Surveys for a system of sewers in connection with the metropolitan system, of Boston, have been prepared by Marshall M. Tidd.

BALLSTON SPA, N. Y.—H. M. Geer has been appointed engineer in charge of the sewer construction.

BUFFALO, N. Y.—The City Engineer is preparing plans for a system of sewerage for all streets south of the Hamburg Canal which discharge into the canal, and all streets on the north side between Sloan St. and the canal. It is proposed to intercept all the sewage now discharged into the Hamburg Canal and carry it into the Swan St. trunk sewer. The cost will probably be at least $100,000, and it is expected that the plans will be completed in about a week.

HAVERSTRAW, N. Y.—The Sewer Commissioners, recently appointed, have organized, with Dr. N. B. Bayley as President, and Wm. H. Waldron as Secretary.

WEEHAUKEN, N. J.—The Council has voted to advertise for bids for a sewer in Willow Ave.

ERIE, PA.—The Councils have passed an ordinance providing for the issue of sewer bonds for $125,000. It is proposed to use $84,000 for finishing the intercepting sewer from Poplar St. to Mill Creek, $22,000 for a sewer in 24th St., and $19,000 for the Ash St. sewer.

KINGSTON, PA.—A system of sewerage is being considered.

LANCASTER, PA.—The City Councils have voted in favor of a loan of $25,000 for sewers.

PHILADELPHIA, PA.—The Councils Committee on Main Sewers, has decided to recommend an appropriation of $1,250,000 for sewers for next year, $250,000 of which will be set apart for the Aramingo system.

MANCHESTER, VA.—The Street Committee will receive bids until Nov. 30 for the construction of a sewer system according to the plans and specifications of Col. Geo. E. Waring, Jr.

COVINGTON, KY.—The City Council has passed an ordinance providing for the construction of the Willow Run sewer. The work will include 3,475 ft. of 14-ft. brick and stone sewer, and is estimated by the City Engineer to cost $110,000.

FORT WAYNE, IND.—The lowest bid for 2.3 miles of 4 to 6-ft. brick sewer was that of F. E. Cole, Toledo, O., $81,330. We shall publish the prices next week.

WEST INDIANAPOLIS, IND.—The Town Board is considering the question of a better system of sewers, and estimates are being prepared for sewers in five streets.

AURORA, ILL.—About 11 miles of sewers are nearly completed in district No. 1, and plans have been approved for sewers in district No. 2. The latter plans provide for about 23 miles of sewers, 196 manholes, 107 lampholes, and 307 catch basins. There will be 105,965 ft. of 9 to 24-in. pipe sewers, and 13,355 ft. of 36 to 72-in. brick seyers, and the estimated cost is about $200,000. The City Engineer hopes to commence work this autumn and to complete the 23 miles within a year. Sewers for district No. 3 will not be considered until next year.

EAST ST. LOUIS, ILL.—Plans for a sewerage system are being prepared by Chas. L. Weber, Cy. Engr. Mr. Weber is now in Chicago investigating the system of that city.

OGDEN, UTAH.—The following bids were received for sewers in district No. 7: C. C. Hobson, $29,028; Hobson & Wilkerson, $29,530; Doyle & Halverson, $30,175; C. W. Kneudsen, $30,384; David Kay, $30.441.

STREETS.

BROOKLYN, N. Y.—The Commissioner of City Works will receive bids until Nov. 16 and 18 for grading and paving. The widening of North Second St. has been ordered to be commenced by Dec. 1. The lowest bids for paving with granite blocks were as follows: Edward Donovan, three contracts, $25,868; Thos. Gilbride, two contracts, $41,199.

BUFFALO, N. Y.—The Board of Public Works has awarded contracts as follows: Barber Asphalt Paving Co., two contracts, $282,802; Buffalo Paving Co., five streets with American bituminous rock, $67,618. The Board voted to pave three additional streets.

NEW YORK, N. Y.—The estimates as finally agreed upon for next year include the following: Department of Public Works, $3,013,670; Department of Public Parks, $1,028,500; Department of Street Improvements in Wards 23 and 24, $349,972; funds for street and park openings, $85,359.

JENKINTOWN, PA.—The lowest bid opened Oct. 31 for macadamizing about three miles of streets was $17,000.

YORK, PA.—The Committee on Highways will receive bids until Nov. 15 for paving about 10,000 sq. yds. with asphalt blocks on six inches of concrete.

MEMPHIS, TENN.—The City Council has voted to pave one street at an estimated cost of $14,000.

WARREN, O.—The City Council has voted to pave two streets with vitrified brick.

BENTON HARBOR, MICH.—About $20,000 will be spent in paving with cedar blocks.

ST. JOSEPH, MICH.—A contract for paving with cedar blocks has been awarded to Geo. A. Mills, at about $20,000.

SANTA CRUZ, CAL.—A boulevard to cost about $15,000 will soon be constructed.

HAMILTON, ONT.—City Engineer Haskins has been making inquiries as to the best article to succeed the block pavement in the city, which is nearly worn out. He has concluded that vitrified brick is the most desirable, providing that the quality of the brick is of the best. The brick should be laid on a concrete base, and is estimated to cost $1.75 per sq. yd. The cost of block paving varies from 65 to $1 per sq. yd., but the vitrified brick, when down, he expects will last much longer than cedar blocks.

ELECTRICAL.

NEWPORT, R. I.—The City Council has voted to contract with the Newport Illuminating Co. for three years for arc lights for street lighting, at 47½ cts. per light per night for 85 lights, or 40 cts. per light per night for 130 lights, the lights to burn every night.

NEW YORK, N. Y.—The Gas Commission has decided to place more electric arc lights in Ogden Ave., Wolf St., Sedgwick and Lind Aves. It has also arranged for 128 additional electric lights in downtown streets now lighted by 640 gas lamps. The electric lights will cost $140 a year each, or $18,688. The gas lights cost only $17.50 a year each, or $5,568 a year less.

ROCHESTER, N. Y.—The contract submitted by the Common Council to the Citizens' Light & Power Co. requires the company to construct a half mile of conduits each year for four years, restricts it from erecting poles on streets where poles now exist, and compels it to remove poles from any street as soon as a conduit is laid therein. The company is required to give a bond of $20,000, and the city is granted the free use of the company's conduits and poles for municipal purposes.

WEEDSPORT, N. Y.—It is reported that the village is being canvassed by parties to whom a franchise has been granted to put in an electric light plant, but we are informed by David Servis, Village Clk., that nothing definite has as yet been developed.

CAMBRIDGE, PA.—Rider, Rowland & Co. offer the village 15 arc lights of 2,000 c. p. each for $70 per light per year, and a special election was held Nov. 9 to vote on the proposition.

JELLICO, TENN.—The erection of a municipal plant is being discussed.

PALATKA, FLA.—The City Clerk will receive bids until Dec. 1 for electric street lighting.

HUDSON, MICH.—The Hudson Electric Light Co. has increased its capital stock to $25,000 and will enlarge its plant. The Schuyler arc and Thomson-Houston incandescent systems are used.

MADISON, ILL.—The town has contracted with G. A. Niemann for ten arc lights of 2,000 c. p. each at $100 per light per year, the lights to be in readiness Jan. 1, 1893.

HAMPTON, IA.—The citizens have voted in favor of erecting a plant for electric street lighting.

SIOUX CITY, IA.—A new company has applied for a franchise to establish a plant for both lighting and power purposes. The company asks for a franchise for 25 years, and agrees to have at least 1½ miles of main line wire erected within 18 mos.

JEFFERSON CITY, MO.—At an election Oct. 31 the city voted in favor of an electric light proposition which provides for not less than 30 all-night arc lights of 2,000 c. p. each, for a term of ten years. The Jefferson City Gas Light, Heat & Power Co. will put in the plant.

CREEDE, COLO.—The Amethyst Electric Light & Power Co. has secured franchises for 20 yrs. from Creede, Upper Creede, Weaver City and Bachelor, and the surveys for a plant have already been made. The power will be taken from the bed of West William Creek, 2,000 ft. of pipe being laid with a fall of 243 ft. to the dynamo house.

NEW COMPANIES.—Suburban Electric Light & Power Co., St. Louis, Mo.; $10,000; S. W. Simmons, Walter Krausnick, Gus George. Edwardsville Electric Light & Power Co., Edwardsville, Ill.; $20,000; W. Wurdack, W. H. Horine, Sr. Cripple Creek Telephone, Electric Light & Power Co.; $100,000.

CONTRACT PRICES.

SEWERS.—Olean, N. Y.—We are informed by Alexander Potter, Engr. in Charge, that a contract for an outlet sewer has been awarded to Mandeville & Johnson at the following prices: 24-in. pipe sewer, 6-ft. cut, $1.06 per lin. ft.; 20-in., 6-ft. cut, 89 cts.; 8 to 8-ft., $1; 8 to 10-ft., $1.25; 10 to 12-ft., $1.60; furnishing and laying 24-in. cast iron pipe in river, $3.17; special manholes, $70 each; ordinary manholes, $35; catch basins with check valves, $55; embankment, 60 cts. per yd.; furnishing and driving beech piles in river, $4 each; hemlock lumber, $9.50 per M. B. M.

Auburn, N. Y.—Bids recently received for several sewers ranged as follows: 36-in. brick, $99 to $133.92 per rod; 24-in. brick, $40 to $81.73; 18-in. tile, $22.50 to $32.56; 12-in., $16 to $18; 10-in., $10 to $32.56; 8-in., $13 to $32.36; 6-in., $7 to $10; 5-in., $8; standard conduits, $40 to $50; brick manholes, $38 to $55; rock excavation, $3 and $3.50 per yd.

Danbury, Conn.—We are informed by J. K. Wilkes, Cy Engr., that the Maple Ave. sewer contract was awarded to Dougherty & Berrigan, Yonkers, N. Y., at the following prices: 24-in. egg-shaped brick sewer, 8-in. work, 4-ft. cut, $5.50 per lin. ft.; 30-in. 12½-ft. cut, $5.95; 36-in., 8½-ft. cut, $6.66; manholes, $40; catch basins, $100.

Denison, Tex.—The City Council has awarded the contract for the extension of the sewer outlet to the Red River, to Jerry Nolan, at 96 cts. per lin. ft., for 9,045 ft. of 18-in. vitrified pipe sewer, and $3.75 per cu. yd. for about 40 yds. of second class masonry, work to begin by Nov. 10, and be completed within 90 days. There were 13 bids for the contract.

STREET WORK.—Chicago, Ill.—The following bids have been received for paving 25,000 sq. yds. of La Salle Ave. with asphalt: Barber Asphalt Paving Co., $2.90 per sq. yd.; Western Paving & Supply Co., $2.65; McArthur Bros., $2.45; Andrew Jaickes, $2.34.

Asheville, N. C.—The contract for paving Bruxton St. with rubble granite has been awarded to Capt. A. M. Smith at $1.50 per sq. yd.

Great Falls, Mont.—The contract for paving Central Ave. has been awarded to Henry Vogel at $3.20 per sq. yd. for two courses of brick on concrete. The bids were published last week.

DRAIN PIPE.—S. Framingham, Mass.—The contract for upward of 4,000 ft. of drain pipe has been awarded to H. L. Sawyer at the following prices: 10-in., 18 cts. per lin. ft.; 8-in., 13 cts.; 6-in., 81 cts.

MISCELLANEOUS.

CANAL.—Ottawa, Ont.—Bids will be received at the Dept. of Railways and Canals until Nov. 22 for sections 8, 9 and 10 of the Soulanges canal. Maps, plans and specifications may be seen at the engineer's office, Coteau Landing, and at this office. T. Trudeau, Dep. Min. of Railways and Canals.

LUMBER.—Montreal, Que.—The Harbor Commissioners have voted to receive bids until Dec. 5 for 300,000 ft. B. M. of hemlock lumber for planking of the wharves in 1893.

PARK BONDS.—Port Arthur, Ont.—The Board of Park Management will receive bids until Nov. 15 for $13,500 of 5% park bonds, interest payable semi-annually.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., will build 45 heavy freight engines for the Pennsylvania. The Cooke Locomotive & Machine Works, Paterson, N. J., are building 20 consolidation engines, with cylinders 21 × 24 ins., and 5 ten-wheel engines, with cylinders 20 × 24 ins., for the Louisville & Nashville; the engines have Belpaire boilers. The Pittsburg Locomotive Works, Pittsburg, Pa., have been testing their two-cylinder compound engine on the Pittsburg & Lake Erie. The Pennsylvania will build 55 heavy freight engines at its shops at Altoona, Pa. The Beech Creek will add 10 engines to its equipment. The Chicago & Alton will place contracts for 10 ten-wheel engines for passenger and freight service; they will have cylinders 19 × 26 ins., and are intended to work on the steep grades of the Western Division.

CARS.—The Michigan Peninsular Car Co., Detroit, Mich., has an order for 600 box cars for the Lake Shore & Michigan Southern. The Tredegar Co., Richmond, Va., has an order for 50 box cars for the Norfolk & Southern. The Ellis Car Co., Amesbury, Mass., is building street cars, and snow plows for street railways. The Mount Vernon Car Mfg. Co., Mount Vernon, Ill., is building 150 coke cars, 100 box cars and 10 cabooses for the Monterey & Mexican Gulf; also 100 box cars and 100 stock cars for the Illinois Central. The New York, Lake Erie & Western Co. has ordered 83 vestibuled cars for the World's Columbian Exposition traffic. The Pennsylvania will add 1,500 freight cars to its equipment, and it is reported that contracts are to be awarded soon for 5,000 passenger and freight cars.

LOCOMOTIVE WORKS.—The Pittsburg Locomotive Works are rebuilding their entire plant at Allegheny, Pa. The building will be of brick, with first class machinery, and Morgan traveling cranes. Machine shop, 125 × 356 ft.; blacksmith shop, 125 × 356 ft.; boiler shop, 120 × 275 ft.; foundry, 80 × 236 ft.

CAR WORKS.—The Lima Locomotive & Machine Co., Lima, O., is rebuilding its car works, which were recently destroyed by fire. The new works will be larger and better equipped than the old works. The Houston Car Co., Houston, Tex., whose incorporation was noted in our issue of Nov. 3, will erect a plant which will have a capacity of 1,000 cars per annum. the first cost of the plant is estimated at $125,000.

PAVING BRICK.—According to press dispatches Charles F. Davis, of Chicago, has closed a deal for a syndicate of Chicago and Pittsburg capitalists for 25 acres of clay shale land just east of Galesburg, Ill. This syndicate proposes to erect a paving brick factory of four plants, each having a capacity of 60,000 brick a day. The company will also sink a large shaft 300 ft. deep to develop the underlying seams of coal. Mr. Davis says that notwithstanding the millions of brick manufactured this year, the outside demand is such that Galesburg has a brick famine. Hundreds of masons and tenders are idle because of the scarcity of brick for the home market. It is said to be the intention of the new company to open up a market in Chicago for vitrified paving brick. The Pittsburg interests are represented by Daniel R. Lane, a banker and blast furnace contractor.

THE THOMSON METER CO., Brooklyn, N. Y., states that meter No. 33,000 was stamped on Nov. 2, the numbers being stamped as the meters are sold and not as manufactured. The numbers sold up to November of the last few years is as follows: 1887, 680 meters; 1888, 2,680; 1889, 4,860; 1890, 10,000; 1891, 20,000; 1892, 33,000.

BINDER & SEIFERT, Chicago, Ill., have the contract for the erection of an iron building for the Krupp gun exhibits at the World's Columbian Exposition. The firm of F. Krupp, of Germany, will have an iron building about 80 × 200 ft., near the lake shore, to house its gun and machinery exhibit and has given the contract for erection as above. The iron work for the building was sent from Germany and has been delivered. Binder & Seifert also have the contract for furnishing all the steel and other materials for the erection of the Taylor St. viaduct in Chicago. This structure is for highway purposes and leads over the tracks of the Northern Pacific R. R., which will pay for it. The cost of superstructure is about $42,000.

PUMPS.—The Courtright Hydraulic Machine Co. is building pumps with a capacity of 100,000 cu. ft. per second for the new drainage canal at Bridgeport, Ill.

THE CURTIS REGULATOR CO., formerly of 63 Beverly, St., Boston, has removed to extensive salesrooms and offices in a large new building of five stories and basement, measuring 75 × 45 ft., at 29, 31 and 33 Haverhill St. The great increase in business has necessitated this move, as well as the building of a five-story, brick factory building, 105 × 45 ft., in Charlestown. This factory is supplied with a 100-HP. Ball high-speed compound engine, and a locomotive boiler, and has its own dynamo and electric lights. A track of the Boston & Maine R. R. runs into the premises. The company is prepared to accept orders for all kinds of high class machinery work, patent articles and specialties, and has been in this line of business for upward of 14 years.

M. RINEY & CO., Chicago, have been awarded a contract for erecting a bridge for the Buffalo Bridge Co., Buffalo, N. Y.

NEW COMPANIES.—Granite City Steel Co., Granite City, Ill.; $1,000,000; F. G. Niedringhaus. Chicago Gas & Crude Oil Burner Mfg. Co., Chicago, Ill.; $1,000,000; W. K. Woodward, C. W. Claybourn, and W. H. Palmer. Centrifugal Milling Machine Co., Chicago, Ill.; $100,000; T. J. Hoyt and S. M. Hoyt. Pioneer Paving Brick Co., Galesburg, Ill.; $60,000; John C. Stewart, L. W. Thompson and James L. Burkhalter.

CURRENT PRICES.

RAILS.—New York: $30 at eastern mills, $30.75 at tidewater; old rails, $16.50 to $17 for iron, and $14 to $14.50 for steel. Pittsburg: $30; old rails, $19.50 to $20 for iron and $15 to $16 for steel. Chicago: $31 to $32.50; light rails, $32; old rails, $18.50 for iron, and $13 to $14.25 for steel.

TRACK MATERIAL.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.4 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts, Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron and steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.7 to 1.75 cts. for iron and steel; spikes 2.05 to 2.1 at mill; track bolts, 2.05 to 2.75 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 57% and 10% and 50% and 10% on black and galvanized butt welded; 67½% and 10%, and 60% and 10% on black and galvanized lap welded. Casing, 55%.

FOUNDRY PIG IRON.—New York: $13.50 to $16. Pittsburg: $13 to $14.25. Chicago: $13.25 to $14.25.

LEAD.—New York: 3.85 to 4 cts.; Chicago: 3.77 to 3.8 cts.; St. Louis: 3.75 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.2 to 2.5 cts. for large lots, and 2.35 to 2.75 cts. for small lots; channels, 2.25 to 2.5 cts.; angles, 1.95 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.85 to 2.1 cts.; steel plates, 1.9 to 2 cts. for tank, 2.2 to 2.25 cts. for shell, 2.5 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2.1 to 2.2 cts.; channels, 2.1 to 2.2 cts.; angles, 1.8 to 1.9 cts.; tees, 2.4 to 2.5 cts.; Z-bars, 2 to 2.1 cts.; universal mill plates, 1.75 to 1.85 cts. for steel; sheared steel bridge plates, 2 to 2.1 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.75 to 2 cts. for tank, 2 to 2.25 cts. for shell, 2.1 to 2.35 cts. for flange, 3.5 to 3.75 cts. for firebox, 2.1 to 2.25 for bridge. Chicago: beams, 2.35 to 2.5 cts.; channels, 2.35 cts.; angles, 2.05 to 2.15 cts.; tees, 2.2 to 2.3 cts.; universal plates, 2.05 to 2.15 cts.; steel plates, 2.1 to 2.15 cts. for tank, 2.17 to 2.25 cts. for shell, 2.3 to 2.4 cts. for flange, and 2.7 to 2.8 cts. for firebox.